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Remedial Activities Summary Report

For:

Former Reichhold / Glacier Northwest Site
5900 West Marginal Way S.W.
Seattle, Washington

April 2008

Prepared for:

Reichhold, Inc.
P.O. Box 13582
Research Triangle Park, NC 27709

and

Glacier Northwest, Inc.
5050 1st Avenue South, Suite 102
Seattle, WA 98134

Prepared by:

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Shaw Environmental & Infrastructure, Inc.

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Signature Page

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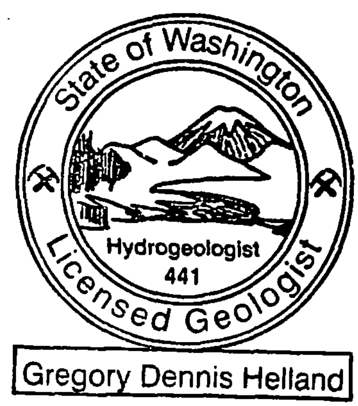

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Table of Contents

Table of Contents (continued)

Tables

Figures

Appendices

1.0 Introduction

This Remedial Activities Summary Report is being prepared on behalf of Reichhold Chemicals, Inc. (Reichhold) and Glacier Northwest, Inc. (Glacier) to support the ongoing remediation of the property located at 5900 West Marginal Way in Seattle, Washington, herein referred to as the site (**Figure 1-1**). The information presented in the Remedial Activities Summary Report (RASR) is a summary of the remedial activities and supplemental investigations that have taken place at the site since 1997.

In 1998, Reichhold and Lone Star, Inc. (now Glacier) jointly entered into a contract with Fluor Daniel GTI, Inc. (FD-GTI) to perform remediation of the site. The IT Corporation subsequently acquired FD-GTI. Shaw Environmental & Infrastructure, Inc. (Shaw) acquired certain assets of FD-GTI/IT Corporation in 2003 and took over the remediation efforts at the site.

1.1 Regulatory Involvement

Considerable environmental work was performed at the site prior to FD-GTI beginning remediation activities. In 1995, Hart Crowser, Inc. submitted a letter to the Washington Department of Ecology (Ecology) on behalf of Reichhold requesting initial review of a proposed, independent RI/FS at the site (Hart Crowser, 1995). That letter was the initial entrance of the site into Ecology's Voluntary Cleanup Program (VCP) administered under the Model Toxics Control Act (MTCA) Cleanup Regulations. Since then, the site has continued with voluntary cleanup efforts.

Also in 1995, a Notification of Dangerous Waste Activities was filed with Ecology for the "Lone Star Northwest/Reichhold Chemical MTCA Cleanup" (Lonestar NW/Reichhold Chemical MTCA Cleanup 1995). The EPA ID Number associated with this notification is WAR000006221 (SAIC, 2007).

A letter from Lone Star was sent to Ecology in 1998 indicating that the planned cleanup actions would include well installation, ozone sparging, arsenic fixation, and sampling and analysis (Reichhold, 1998). Ecology did not comment on the planned cleanup actions.

In December of 2007, Ecology contacted both Reichhold and Glacier to inform them that they would be receiving a potentially liable party (PLP) letter from the Agency for impacted soil and groundwater at the site. On February 14, 2008, representatives from Shaw, CH2MHill (representing Reichhold), Glacier, and legal counsel from K&L Gates (representing Glacier) and Perkins Coie (representing Reichhold) met at the site with representatives from Ecology. The purpose of the site meeting was to acquaint Ecology with the investigative and remedial activities that have occurred at the site since 1995.

Ecology issued a MTCA Notice of Potential Liability letter, dated February 26, 2008, requesting a hazard assessment at the site. The PLPs named were Reichhold, Glacier, and the U.S. Army Corps of Engineers.

As a follow-up to the site visit with Ecology in February, Reichhold submitted a letter to Ecology on March 24, 2008 that summarized past investigative and cleanup activities. In addition, copies of the Remedial Investigation Report and Feasibility Study Report prepared by Remediation Technologies, Inc, (RETEC) in 1996 were also submitted to Ecology for review.

1.2 Purpose and Scope

The purpose of this Remedial Activities Summary Report (RASR) is 1) to document the remedial activities that have occurred at the site over the last 10 years, 2) present the findings of remedial and supplemental site characterizations activities, and 3) provide a plan forward to support ultimate site closure.

1.3 Report Organization

The RASR consists of the following sections:

- Section 2 provides a description of the site conditions and history;
- Section 3 summarizes the remedial actions implemented at the site beginning in 1997;
- Section 4 discusses the additional site investigations conducted by Shaw in 2003;
- Section 5 provides a summary of the current understanding of site conditions; and
- Section 6 includes a Summary and proposes a plan forward to support ultimate site closure.

The references are listed in Section 7.0.

2.0 Site Background

This section briefly describes the site, its current condition, the site history, and the geologic setting.

2.1 Site Description

The Glacier facility, occupying approximately 18 acres, is located near the Duwamish River in an industrial area of Seattle and is situated within S1/2, SE1/4, Section 19, T24N, R4E, King County, Washington. The facility, currently owned by Glacier, is zoned for industrial use and will remain industrial into the foreseeable future. The portion of the property that is the subject of this RASR is used to park concrete trucks and other concrete operations equipment at night and employee cars during the day.

The upland areas adjacent to Glacier and the Lower Duwamish Waterway have been industrialized for many decades. Historical and current commercial and industrial operations in the vicinity of the site include cargo handling and storage, marine vessel repair and maintenance, concrete manufacturing, lumber milling, charcoal production, manufacture of glues and resins, and tin reclamation.

Properties located directly north of the site include the Former Duwamish Shipyard (sold to Alaska Marine Lines in 2007) adjacent to the north, followed by Alaska Marine Lines, Chemithon and Lafarge Corporation, and to the south is Port of Seattle Terminal 115, including the former MRI Corporation, which leased the northwestern portion of Terminal 115. To the west of these properties is West Marginal Way SW; across this roadway to the west is additional property owned by Alaska Marine Lines as well as green space owned by the city of Seattle Parks Department and several privately-owned parcels. The Lower Duwamish Waterway (LDW) borders the property to the east. The site and area land use map is provided in **Figure 2-1.**

2.2 Site History

The site was used for charcoal filter production by the U.S. Army from 1943 to approximately 1947. Reichhold leased the property from the U.S. Army in 1947 and began producing resin glues for use in plywood manufacturing (RETEC, 1996). Reichhold also used the site for the pilot-scale production of pentachlorophenol and sodium pentachlorophenate, which are used as wood preservatives. Full scale production of pentachlorophenol and sodium pentachlorophenate did not occur at the Glacier property.

Historical records and subsurface investigations at the site have identified fill materials across the site. Similar to the river fill, contaminated fill may have been deposited directly onto the site during historic grading activities. The general practices of that time indicate that dredge materials from the Duwamish were typically used as fill material. These sediments could potentially have been impacted with arsenic prior to dredging and deposition onto the site.

Reichhold moved their operations to Tacoma between 1956 and 1960. The property remained inactive from 1960 to 1964 when the Army Corps of Engineers transferred ownership to the Port of Seattle.

Kaiser Cement Company leased the land from the Port of Seattle and operated a cement terminal on the property from 1964 to 1987. Glacier or its predecessors assumed ownership of the property in 1987 and continues to operate a cement distribution terminal. The remediation efforts have been focused on a portion of the property that is currently used to park concrete trucks and other concrete operations equipment at night and employee cars during the day.

2.3 Summary of Previous Studies

Geotechnical and environmental investigations were performed as part of past property transactions and past construction activities. The geotechnical investigations were performed by Shannon and Wilson in 1964, 1966 and 1969 and by Hart Crowser in 1975. Several environmental investigations were performed by different firms. Briefly summarized below are the results of previous environmental investigations performed by Parametrix, Inc. in 1985 and 1990, Hart Crowser in 1995, and RETEC in 1996.

Final Report, Kaiser Property Environmental Audit, prepared for The Port of Seattle by Parametrix, May 21, 1985

The work was performed in anticipation of a property transaction. The work included a review of site history and laboratory analysis of four composite soil samples created from 24 soil samples collected from 12 soil borings. The composite soil samples were analyzed for priority pollutants. Trace concentrations of pesticides (aldrin, alpha – BHC, dieldrin) and phthalates were detected along with arsenic. Arsenic concentrations ranged from 20 milligrams/kilogram (mg/kg) to 51 mg/kg. Recommendations were made related to worker health and safety during construction activities.

Phase II Site Assessment, 5900 West Marginal Way, Seattle, prepared for Lone Star Northwest by Parametrix, August 1990

The work included the installation of three groundwater monitoring wells and excavation of five shallow soil test pits. Soil samples were collected from the well borings and test pits, and groundwater samples were collected from the wells. The results indicated the presence of pentachlorophenol in groundwater near the former acid neutralization pond; arsenic and silver in the groundwater and arsenic in the soils in the eastern portion of the site; and total petroleum hydrocarbons in surficial soils in several isolated locations. It was recommended that the investigation should be expanded to determine the source and assess the extent of pentachlorophenol, arsenic and silver contamination.

Request for Initial Review of Proposed RI/FS for Independent Cleanup Reichhold/Lone Star Site, prepared for Department of Ecology by Hart Crowser, August 1995

The letter report presented a summary of site history, soil and groundwater quality conditions and recent seep sampling results. Three prominent surface water seeps were sampled. The analytical results indicated that silver, pentachlorophenol and total petroleum hydrocarbons (TPH) were not detected in any of the seep samples. Arsenic was detected at concentrations ranging from 30 micrograms per liter (µg/L) to 85 µg/L. A preliminary outline of a remediation investigation / feasibility study (RI/FS) work plan was also provided.

Remedial Investigation Report, Lone Star/Reichhold Site, prepared for Reichhold Chemical and Lone Star Northwest by Remediation Technologies, May 1996

The purpose of the RI and subsequent FS was to characterize the site in accordance with Ecology requirements and to enable the two parties to implement an appropriate independent cleanup. The RI included soil and groundwater sampling of 14 test pits, 16 direct push borings, and 7 hollow-stem auger borings and development of 10 groundwater monitoring wells. Select soil and groundwater samples were analyzed for pentachlorophenol, chlorinated phenols, TPH, arsenic, silver, and formaldehyde. The report identified potential sources areas, constituents of potential concern (COPCs), and identified concentrations of COPCs detected in soil and groundwater onsite. Copies of the data tables from the RETEC RI Report are provided in **Appendix A** and RETEC boring logs are included in **Appendix B**.

<u>Potential Source Areas</u>

Several potential sources of COPCs were identified in past studies, memos and a 1954 plot plan:

- Tank Farm (in 1954 plot plan, included 10 tanks that handled phenol-containing waste)
- Wastewater Impoundment (constructed in 1955 and closed in 1960; received wastewater containing hydrochloric acid, a by-product of the pilot-scale pentachlorophenol production)
- Water Treatment Tank (received waste from entire facility, no longer present due to change in shoreline)
- First Pentachlorophenol Pilot Area/Formaldehyde Production Area

The FS presented the site conditions based on the RI and estimated the volume of pentachlorophenol-affected soils in the two source areas: Second Pilot Plant (1,320 cubic yards) and Former Impoundment (2,080 cubic yards). It also estimated the volume of arsenic-affected soils at 13,130 cubic yards and theorized that the source of the arsenic at the site might be from former metals sludge dewatering ponds located immediately south of the site in the 1960s and early 1970s.

2.4 Site Setting and Conditions

The subsurface conditions were characterized during the RI performed by RETEC in 1996. The RI conducted by RETEC followed earlier investigations performed by Parametrix and Hart Crowser. Additional investigations were conducted by FD-GTI prior to remedial activities. This section summarizes information on the site environmental setting. The current site plan, including boring and monitoring well locations is shown in **Figure 2-2.**

2.4.1 Geology

The surface of the site is largely unpaved and is covered with a layer of gravel and crushed rock to approximately 1 foot bgs (Hart Crowser, 1995). The site is mantled by a surface layer of fill material which consists of silt, sand, gravel and concrete debris. This fill layer extends to a depth of approximately 3 to 5 feet bgs. No specific information has been available to determine where the fill material originated. The general practices of that time indicate that dredge materials from the Duwamish were typically used as fill material.

The fill material is underlain by a sand layer 8 to 13.5 feet thick. This sand layer has been defined as fine to medium fine, well graded to poorly graded sand with a color ranging from gray to black (RETEC, 1996). The sand layer is typically wet from 5 to 6 feet bgs. At approximately 8.5 to 15.5 feet bgs there is a silt layer that is approximately 5.5 to 6.5 feet thick. The silt is slightly clayey, low to medium plasticity, contains some organic material and is usually dry to moist. The silt layer serves as a barrier between the shallow aquifer and the lower aquifer (see below). The silt layer is underlain by a sand layer that is greater than 11.5 feet thick. This lower sand layer is first encountered at 15 to 18 feet bgs and consists of well graded to poorly graded sands defined as black, fine to coarse sand. This lower sand layer is moist to wet. Cross sections A-A', B-B', and C-C' (**Figures 2-3** through **2-5**, respectively) present the lithology observed in exploratory borings completed at the site to date. Cross section locations are illustrated on the Site Plan (**Figure 2-2**).

2.4.2 Hydrogeology

Two distinct saturated zones have been identified underlying the facility. Perched groundwater present within the fill and upper sand units is encountered beneath the site between 4 and 13 feet bgs. This perched groundwater unit (also referred to as the shallow aquifer) is above the organic silt and clay layer, which acts as an aquitard (Hart Crowser 1995). There is a lower aquifer beneath the silt/clay aquitard layer. Groundwater in the deeper zone generally flows to the northeast toward the Duwamish River (Hart Crowser 1995).

The saturated thickness of the shallow aquifer varies across the site and also varies with seasons. While seasonal trends have not been determined, it appears that the saturated thickness of the shallow aquifer is at a minimum during the drier months between June and October and at a maximum during the winter months of December, January, and February. The saturated thickness of the shallow aquifer also varies over the site with a general trend of being thickest in the northern portion of the site and thinning towards the southern portion of the site.

The general direction of groundwater flow in the shallow aquifer is to the southeast. Groundwater elevation data indicates the presence of a depression in the groundwater table in the southeastern portion of the site, which may be caused by a storm sewer located to the south of the site beneath the Terminal 115 North Access Road or by the former Duwamish River Channel that was historically located in this area. Slug tests performed by RETEC in 1996 resulted in an average hydraulic conductivity in the shallow aquifer of approximately 3.48 feet per day.

2.4.3 Tidal Effects

Tidal studies performed during the RI showed that the shallow aquifer was not influenced by tidal fluctuations. The only exception to this was monitoring well MW-3s (located in the southeastern portion of the site), which consistently has lower water levels relative to other shallow wells at the site (RETEC, 1996).

A 48-hour tidal study was completed by RETEC from January 24 to 26, 1996 to determine the effects of tidal and river stage influences on groundwater flow gradient and direction. Water levels in monitoring wells MW-1S, MW-1D, MW-2S, MW-2D, MW-3S, MW-3D, and MW-4S (all adjacent to the Duwamish River) were gauged over a 48-hour period. There was a slight rise in the water level at MW-3s following a relatively high tidal event when the elevation of the river exceeded the water elevation in MW-3s by approximately 1 foot. The lower aquifer appears to be tidally influenced, but no comprehensive study has been performed. Based on preliminary assessments of the confined aquifer performed in 1996, the potentiometric gradient may shift toward the river during low tide events and away from the river during high tide events.

2.5 Pre-Remedial Action Characterization

During November 1997, FD-GTI installed additional monitoring wells and collected soil and groundwater data to aid in the design of the remediation systems. Monitoring wells MW-8s and MW-9s were installed between monitoring wells MW-4s and MW-7s in the area of the second phenate pilot plant. The monitoring wells were installed using hollow stem augers to a depth of approximately 11 feet bgs and completed with flush-mounted protective vaults at surface grade. Wells MW-8s and MW-9s were installed to conduct pilot remediation studies.

Monitoring wells MW-10 through MW-21 were installed on October 13 and 14, 1998 to supplement the existing network of monitoring wells in the shallow saturated zone. The wells were installed to various depths across the site, with MW-10 and MW-11 installed to approximately 10.5 feet bgs, MW-12 through MW-17 installed to approximately 11.5 bgs, and MW-18 through MW-21 installed to approximately 13.5 bgs. The boring/monitoring well logs are included in **Appendix B**.

Two soil samples were collected from each soil boring prior to installing the monitoring well. Specifically, one sample was collected from the 5.5 to 6.5 feet bgs interval, and one sample was collected from the bottom 0.5 to 1 foot interval in each boring. Samples were submitted to North Creek Analytical Laboratories for analysis of arsenic and PCP using US EPA Methods 6020 and 8270C, respectively. Laboratory reports for the soil analytical results are provided in **Appendix C**.

2.5.1 Soil Results

Soil analytical data collected during the installation of monitoring wells MW-10 to MW-21 is presented in **Table 2-1**. Based on the analysis, the highest recorded arsenic concentrations were observed in soil samples collected from monitoring well MW-19. The soil sample collected from 5.5 to 6.5 feet bgs interval in MW-19 yielded an analytical value of 1,290 mg/kg for arsenic, while the 13 to 13.5 feet bgs interval yielded a concentration of 2,240 mg/kg. The soil samples from the remaining locations each had detectable concentrations of arsenic, but were well below those observed in MW-19. Generally, the higher arsenic concentrations are associated with soil samples from the saturated zone.

Soil samples from monitoring wells MW-10 through MW-13 and MW-15 through MW-17 were submitted for laboratory analysis of PCP. PCP was detected in only 5 of the 14 soil samples.

The highest PCP concentration was recorded at 4.4 mg/kg and was observed in the soil sample collected from the 11-11.5 feet bgs interval in monitoring well MW-13. PCP concentrations in the 5.5-6.5 feet bgs interval soil samples collected from monitoring wells MW-10 and MW-11 were 1.92 mg/kg and 1.58 mg/kg, respectively. These three wells, MW-10, MW-11, and MW-13, are located within the former impoundment area. The remaining samples yielded non-detect or low-level analytical values. None of the PCP sample results exceeded the MTCA Method C Soil Cleanup Level (MTCA Method C) of 1,090 mg/kg calculated for the site or MTCA Method B Soil Cleanup Level of 8.3 mg/kg.

2.5.2 Groundwater Results

Groundwater samples were collected on November 2, 1998 from the newly installed monitoring wells MW-10 through MW-21, in addition to existing monitoring wells MW-1s through MW-7s. **Tables 2-2** and **2-3** summarize the analytical results for arsenic and PCP in groundwater, respectively. Laboratory reports for groundwater analytical data are provided in **Appendix D.**

Groundwater samples from MW-2s, MW-3s, MW-10 through MW-14, and MW-17 through MW-21 were analyzed for dissolved arsenic. Concentrations of dissolved arsenic ranged from 4.17 μg/L in MW-20 to 775 μg/L in MW-13 (see Table 2-2).

Groundwater samples from MW-1s, MW-2s, MW-4s through MW-7s, MW-10 through MW-13, and MW-15 through MW-17 were analyzed for PCP. PCP was detected in seven of the 13 wells sampled (see Table 2-3). Concentrations of PCP in groundwater ranged up to 8,040 μg/L in MW-13. The next highest concentrations were more than 2 orders of magnitude lower at 63.2 μg/L in MW-10 and 11.2 μg/L in MW-11. These were the same three well locations of the highest PCP soil concentrations.

2.6 Understanding of Pre Remediation Subsurface Concentrations

The two COPCs at the site are PCP and arsenic. Earlier reports suggested that silver and TPH were potential constituents of concern. However, the RI determined that silver was not a constituent of concern for the site. While other chlorinated phenols were detected during the RI, PCP was always associated with these and was present at much higher concentrations. The ozone system selected is for dechlorination of PCP and associated breakdown products.

2.6.1 Pentachlorophenol

<u>Pentachlorophenol in Soil.</u> During the RI, PCP was found in soil primarily in the north central area of the site where Reichhold formerly operated a PCP pilot scale production plant and in a former impoundment area. The RI concluded that pentachlorophenol soil concentrations ranged

from non-detect to approximately 830 mg/kg. Pentachlorophenol concentrations did not exceed the MTCA Method C cleanup levels for industrial soil.

However, during this recent review of the laboratory reports provided in the RETEC RI report, Shaw discovered that the highest PCP concentration in soil was 1,000 mg/kg collected from GP-16 at 7 to 8 feet bgs, which is below the MTCA Method C Soil Cleanup Level for PCP. GP-16 is located within the arsenic treatment zone discussed in Section 3. **Figure 2-6** presents the pretreatment concentrations of PCP in soil.

Pentachlorophenol in Groundwater. PCP was also detected in groundwater samples collected in the vicinity of the former PCP pilot scale production plant and in the former impoundment area. The two PCP plumes do not appear to be connected and may have been a result of two separate release processes. PCP in groundwater is likely a result of PCP solids dissolving in groundwater. **Figure 2-7** presents the peak pretreatment concentrations of PCP in groundwater.

2.6.2 Arsenic

Arsenic in Soil. It is well-documented that Reichhold and Glacier never used arsenic on this property. As stated earlier, the source(s) of the arsenic on the site is assumed to be a fill issue. Based on the RI, arsenic contaminated soil was determined to be restricted to the southeastern portion of the site. The highest concentrations of arsenic in soil were found in the south-central portion of the site in the vicinity of a former east-west running ditch.

Figures 2-8 and **2-9** present the lateral presence of arsenic in soil at depths of 0 to 7 feet bgs, and 7 to 16 feet bgs, respectively. The results of soil sampling indicate that the highest concentrations of arsenic in soil are present in the south-central portion of the site extending at depth to the southern property boundary.

Arsenic concentrations detected in 9 of the10 soil samples collected (RETEC, 1995) from 0 to 7 feet bgs in the northern portion were less than 30 mg/kg. Composite soil samples (Parametrix, 1985, Composite Sample No. 1) and one soil sample (RETEC, 1995, Test Pit 6) collected in the northeast portion of the site had concentrations of total arsenic of 51 mg/kg and 48 mg/kg, respectively.

The highest arsenic concentrations reported from soil samples are located at depths between 7 and 16 feet bgs, which are depths associated with the shallow groundwater zone. A soil sample collected from boring GP-9 at a depth of 11 to 12 feet bgs located near the eastern edge of the property had an arsenic concentration of 1,100 mg/kg. A soil sample collected at a depth of 13 to 13.5 feet bgs from the boring for monitoring well MW-19, located in the south-central portion of the site, had an arsenic concentration of 2,240 mg/kg.

The soil sampling data from shallow (surface to 7 ft bgs) and deep (7 to 16 ft bgs) soils indicate that arsenic is present in concentrations greater than 30 mg/kg in the areas sampled in the central and south-central portion of the site. The furthest west and north portions of the property (within 200 feet of the property line) have had minimal soil sampling to identify potential arsenic source areas. A composite of 3 soil samples collected from the west portion of the property (Parametrix, 1985, Composite Sample No. 4) had an arsenic concentration of 20 mg/kg.

Arsenic in Groundwater. **Figure 2-10** presents estimated isoconcentration contours of dissolved arsenic in groundwater prior to remediation. The figure presents both the estimated dissolved arsenic concentrations to 500 µg/L as estimated by RETEC in the RI and the isoconcentrations to 100 µg/L based on the additional monitoring well data from the FD-GTI 1998 sampling event. Arsenic concentrations in groundwater were highest in the southeast portion of the site near the property boundary. The RI postulated that arsenic on the site may be from off-site sources.

2.6.3 Seep Data

Two different seep sampling events have been conducted along the shoreline adjacent to this site. One was conducted by Hart Crowser in 1995. A more extensive survey and sampling of seeps along the LDW was conducted by Windward Environmental, LLC (Windward) in 2004. The two investigations are summarized below. The approximate seep sample locations are shown on Figure 2-2.

Hart Crowser collected water samples from three surface water seeps on May 15, 1995. The seeps were observed to discharge from the shoreline adjacent to the site and appeared to reflect discharges from the perched groundwater zone. Samples collected from these seeps were designated as locations SW-01, SW-02, and SW-03 (shown on Figure 2-2). Sampling corresponded to early flood tide conditions which occurred immediately after a relatively low tide event on that day. Sampling at all three locations occurred as late as possible during the rising tide, but before inundation of the sampling locations, to allow for maximum drainage of seawater (Hart Crowser, 1995).

The seep samples were submitted for laboratory analysis of arsenic, silver, semi-volatile organics (SVOCs), and TPH. Silver, pentachlorophenol and breakdown products, and TPH were not detected in samples SW-01, SW-02, and SW-03 and therefore did not exceed the ambient surface water quality criteria and MTCA cleanup levels. Total arsenic concentrations were detected in SW-01 at 85 μg/L, in SW-02 at 82 μg/L and in SW-03 at 30 μg/L. (Hart Crowser, 1995).

In July of 2004, two seeps (61 and 62) were identified along the shoreline of the site by Windward. The area was characterized as an area with high seepage level as several rivulets were observed flowing along the shoreline. Seeps 61 and 62 were selected for sampling because the water associated with Seep 61 was discolored and a sulfide odor was observed during the seep reconnaissance survey, and dioxins/furans were detected in the sediment near Seep 62 (SAIC, 2007).

Samples from Seeps 61 and 62 were analyzed for metals, mercury, SVOCs (including pentachlorophenol and its breakdown products), VOCs, PCBs, organochlorine pesticides, TOC, dissolved organic carbon, and TSS. Volatile organics and SVOCs were not detected in the seep samples. Organochlorine pesticides were not detected in either sample; however, the reporting limits for three pesticides in the Seep 61 sample were greater than the marine chronic water quality criteria (WQC). Arsenic, cadmium, lead, mercury, silver, and zinc concentrations were reported in the seep samples. The filtered arsenic concentration reported in Seep 61 (72.4 μg/L) exceeded the chronic and acute (36 and 69 μg/L, respectively) WQC (Windward, 2004). .

Acute WQC represent 1-hour average concentrations not to be exceeded more than once every three years on the average for metals and PCP. Chronic WQC represent 4-day average concentrations not to be exceeded more than once every three years on the average for metals and PCP. Acute and chronic WCQ for metals (except the chronic WQC for mercury) represent dissolved concentrations, therefore, comparisons are made using filtered samples (WAC 173-201).

The direct comparison of seep concentrations to WQC are provided as a preliminary screening of seep data. Seeps do not represent a constant source of exposure to aquatic organisms in the LDW; however, the exposure period for chronic criteria is based on a continuous 4-day average concentration. Therefore, the applicability of chronic WQC to seep water as an indicator of risk to aquatic organisms needs to account for exposure duration in future comparisons.

3.0 Summary of Remedial Action Activities

FD-GTI conducted several investigations and treatability studies and began implementing a remedial action plan in 1998. Based on previous remedial investigations, the PCP-impacted soil and groundwater was understood to be primarily located in the north central area of the site where Reichhold formerly operated a PCP pilot scale production plant; and in the east central area of the site in a former impoundment area. The arsenic-impacted soil and groundwater was understood to be primarily in the south central and southeastern areas of the site (source of arsenic was not established based on site history). The remediation was performed as an independent remedial action under MTCA (WAC 173-340-515) with Ecology oversight under the Voluntary Cleanup Program.

3.1 General Remedial Approach

An ozone sparging system was designed and installed to treat PCP in soils and groundwater at the site. The north PCP source area had 22 sparging wells and the former impoundment had 28 sparging wells. A soil vapor extraction (SVE) system was also installed to capture ozone that wasn't oxidized in the subsurface. The field testing, system installation, operational history, and observed results of the ozone sparging system are discussed in the following sections.

The arsenic-impacted soil and groundwater was treated using enhanced *in situ* fixation. Hydrogen peroxide was injected in 28 locations in the southern portion of the site during two treatment episodes in February/March 2000 and July/August 2000 to enhance the *in situ* immobilization of arsenic through oxidation processes. The hydrogen peroxide was used to oxidize and precipitate both arsenic and iron in the groundwater to produce an amorphous iron-arsenate hydroxide. The field testing, application, and observed results of the hydrogen peroxide injections are discussed in the following sections. **Figure 3-1** provides a design schematic of the ozone sparging and in-situ fixation remediation systems. Boring/well logs and reports related to the installation of the remediation systems are provided in **Appendix E.**

3.2 Pentachlorophenol

Pentachlorophenol in soil and groundwater at the site was treated using *in-situ* ozonation. Ozone has been shown to be effective in the remediation of a variety of organics, including PCP (Nelson and Brown, 1994). Ozone will react with PCP according to the following reaction:

$$C_6Cl_5OH + 9\ O_3 + 2\ H_2O \rightarrow 6\ CO_2 + 9\ O_2 + 5\ HCL \quad (1)$$

According to equation 1 and the molecular weights of the reactants, approximately 1.6 pounds of ozone are needed to oxidize each pound of PCP.

The ozone system utilized air sparging to inject ozone. Air sparging is the introduction of air under pressure below the water table. This creates a transient air filled porosity by displacing water in the soil matrix. Air moves laterally and vertically away from the sparge well and exits the water table into the vadose zone.

3.2.1 Field Testing to Support In Situ Ozonation

Air sparge and SVE tests were conducted in November 1997 to obtain key design parameters for the *in situ* ozonation system. The key to successful operation of direct *in situ* groundwater treatment is attaining good contact between the injected ozone and contaminated media. The injected ozone must be able to travel horizontally and vertically through the contaminated saturated zone so that it will react with the PCP. Therefore, it was important to determine the lateral spreading of the injected air in the saturated zone (i.e., the radius of influence or ROI).

To conduct the air sparging and SVE tests, an air sparge well (AS-1) and two additional monitoring wells were installed in the area of the second phenate pilot plant, between monitoring wells MW-4s and MW-7s (**Figure 2-2**). The air sparge test was conducted on November 18, 1997. The test was performed by injecting air into the subsurface through well AS-1 and measuring saturated and vadose zone parameter changes at varying distances from the injection well in monitoring wells MW-9s (6.5 feet from AS-1), MW-8s (12 feet from AS-1), MW-6s (21.5 feet from AS-1), and MW-7s (22 feet from AS-1). The depth to water, dissolved oxygen, oxygen, and pressure were monitored in each of the monitoring wells throughout the test.

The SVE test was conducted on November 19, 1997. The test was conducted by applying a vacuum on monitoring well MW-9s and monitoring the induced vacuum at MW-8s (6 feet), MW-6s (15 feet), and MW-7s (28 feet). The test was designed to determine the site specific ROI and to test for fugitive volatile organics.

During the air sparge and soil vent test, soil gas was monitored for volatile organics using several portable instruments. Soil gas monitoring indicated that a volatile organic compound was present during the test. When a sample of the gas was sent to the laboratory for analysis, the results indicated that the volatile organic was methane. The concentration of the methane was 76.5 μg/L. This concentration of methane is not unusual and indicates that the subsurface is anaerobic.

The air sparge and SVE test indicated that the effective ROI for the air sparge system was approximately 20 feet while the ROI of the SVE system was approximately 10-15 feet. Both of these values were incorporated into the final design of the system.

3.2.2 System Installation

The in situ ozonation system was installed in March, 2000. The first step to implementation consisted of installing sparge wells within the area formerly occupied by the PCP pilot scale production plant and within the former impoundment. One-inch stainless steel sparge points were driven into the subsurface to a depth of approximately 12 feet bgs. The maximum distance between sparge points was 30 feet, which corresponds to the effective radius of influence observed during the pilot scale testing. Each sparge point was connected by manifold to the treatment compound through a pressure regulator and 2-inch diameter stainless steel piping.

The treatment compound consisting of a pre-fabricated building with a concrete floor was used to house the air sparging/soil vapor extraction equipment and the ozone generator. The ozone sparging system included subsurface and above-ground piping installed in the north central and east central areas, and a mobile equipment trailer, which was equipped to operate/ozonate each area separately. The mobile equipment trailer consisted of an air compressor, an oxygen generator, and an ozone generator. Ozone produced from the ozone generator flows through a venturi tube and mixed with air from the air compressor. Flow control and safety was provided by stainless steel solenoid valves, pressure regulators, check valves, and Teflon seals and discs.

3.2.3 System Operation and Performance

Operation of the in situ ozonation system underwent shakedown and startup in April/May 2000. An immediate reduction in PCP concentrations was observed during the groundwater monitoring event completed on July 6, 2000. All site monitoring wells sampled during the event showed a noticeable decrease in PCP concentrations from those collected during the March 16, 2000 event. Laboratory reports for groundwater analytical results are provided in **Appendix D**.

Monitoring well MW-13 historically had the highest levels of PCP impact, with the March 16, 2000 sample yielding an analytical concentration of 3,410 µg/L. The July 6, 2000 sample from MW-13 yielded 849 µg/L, indicating a 75 percent reduction in PCP from one quarter of remediation. A subsequent groundwater sample collected on March 21, 2001 showed a similar response with the concentration reduced to 131 µg/L, indicating an 85 percent reduction from the July 6, 2000 sample result of 849 µg/L. Samples collected on May 31 and August 13, 2002 yielded PCP concentrations of 12 µg/L and 10 µg/L, with MW-13 concentrations reduced to non-detect levels on May 12, 2003. The analytical results for PCP in groundwater are provided in **Table 3-1**. For continuing PCP groundwater monitoring discussions, see section 3.5 below.

3.3 Arsenic

Dissolved arsenic in groundwater was treated by an oxidative process, intended to result in the geochemical fixation of the arsenic. While ozone could have been used for this process, hydrogen peroxide was selected as the oxidizing agent due to the separation of the arsenic and PCP plumes and high costs associated with ozone.

3.3.1 Field Testing to Support Arsenic Precipitation

Field tests were conducted in March 1998 to determine the feasibility of using an oxidative process for treating arsenic at the site. A modified "push-pull" test was conducted to evaluate the feasibility and to determine the effective radius of influence for designing an infiltration system for *in situ* geochemical fixation. This test consisted of an injection ("push") of hydrogen peroxide (H_20_2) into the saturated zone at the site followed by the extraction ("pull") of the water from the same well. The H_20_2 reacts with dissolved iron and arsenic in the groundwater and oxidizes both to precipitate a ferric-arsenate hydroxide, which has a low solubility and is stable as long as conditions remain oxidizing. During the extraction phase of the test, flow was reversed and the concentration of arsenic in the extracted water was monitored until breakthrough was achieved. Breakthrough indicated that the injected solution exceeded its ability to react with the arsenic in the groundwater. The "push-pull" test performed at the site was modified to include a ROI test. This was performed by injecting a 3% H_20_2 solution into one well and monitoring groundwater elevation and dissolved oxygen concentrations in surrounding monitoring wells.

To conduct the "push-pull" test, two monitoring wells (PP-1 and PP-2) were installed in the proximity of MW-3s (**Figure 3-1**). Monitoring well PP-2 was installed to a depth of 10 feet and located approximately 10 ft from MW-3s. Monitoring well PP-1 was also installed to a depth of 10 feet but located 20 feet from MW-3s. Another well (INJ-1) was installed to a depth of 7.5 ft (just above the high water level of the shallow aquifer) and approximately 25 ft from MW-3s. INJ-1 was to be used as the infiltration well for the ROI test. However, during preliminary testing it was discovered that the infiltration rate was too low to provide useful information, so INJ-1 was not used during the actual test. Monitoring well PP-1 was used for the ROI testing.

The "push-pull" test was conducted during March, 1998. Before beginning the tests, PP-1 and PP-2 were purged and sampled. The groundwater was analyzed for arsenic, ferrous iron, and DO. To initiate the "push-pull" test, approximately 250 gal of a 3% H_20_2 solution was infiltrated ("pushed") into PP-2. The solution flowed radially away from PP-2 and reacted with the arsenic and ferrous iron for 24 hours. After 24 hours, approximately 530 gals of groundwater was extracted ("pulled") from PP-2. Groundwater samples were collected and DO and groundwater elevations were measured prior to the start of the extraction phase and during selected intervals during the extraction. Groundwater samples were analyzed for ferrous iron and arsenic.

The initial arsenic concentration in PP-2 was approximately 6,450 μg/L. Following the addition of approximately 250 gals of a 3% H_20_2 solution, the concentration of arsenic in PP-2 fell over 99% to approximately 49 μg/L indicating that the H_20_2 was effective in reducing arsenic concentrations. The ferrous iron concentration went from 405 mg/L to 8.27 mg/L and the DO went from 0.45 mg/L to > 19 mg/L. These three results indicated that the H_20_2 solution was reacting strongly with the ferrous iron and arsenic to form the ferric-arsenate hydroxide.

As water was extracted from PP-2, the concentration of both the arsenic and the ferrous iron increased. Arsenic concentrations increased up to six fold to 315 μg/L during the extraction but still remained less than 5% of the pre-test concentrations. The ferrous iron concentration increased to pre-test levels after extracting 50 gals and continued to rise to 763 mg/L until approximately 220 gals of groundwater had been extracted, at which time the concentrations of ferrous iron decreased to below pre-test levels. While the variability of the ferrous iron was insignificant for the purposes of these tests, the high levels of ferrous iron in the groundwater was considered encouraging from the perspective of the full scale treatment because iron would not be a limiting factor at the site.

Following the "push-pull" test, a radius of influence test was conducted by infiltrating 650 gals of a 3% H_20_2 solution into PP-1 and monitoring DO and groundwater elevations in PP-2 and MW-3s. Groundwater samples were collected in PP-1, PP-2, and MW-3s at the beginning and the end of the ROI test. The pre-test concentration of arsenic in PP-1 was 1,880 μg/L. Following the completion of the test, the arsenic concentration in PP-1 decreased to 4.3 μg/L, a greater than 99% reduction. Dissolved oxygen and groundwater elevation readings collected for MW-3s (20 ft from PP-1) rose significantly during the ROI test, indicating that the effective ROI for this area was at least 20 ft.

The results of the "push-pull" test showed that that the use of hydrogen peroxide could be effective in reducing the arsenic concentrations to below MTCA Method A cleanup levels. The ROI test indicated that the ROI for the treatment system is at least 20 ft. This information was incorporated into the final design of the arsenic fixation system.

3.3.2 System Installation

The hydrogen peroxide infiltration gallery was constructed in the south central area of the site. The infiltration gallery consisted of a series of underground slotted PVC piping, with solid PVC risers, spaced 50 feet apart, manifolded to a header. The piping was capped in a traffic-rated well box.

The infiltration gallery was constructed in two-foot wide trenches, approximately eight feet deep, with the piping laid at a depth of seven feet bgs. The piping consisted of four-inch diameter Schedule 40 PVC slotted (0.020) pipe, with sand backfill to approximately three feet bgs, and native backfill to the ground surface. The bottom four feet of backfill was tamped to prevent excess settling. The top four feet of backfill was compacted to 95 percent.

3.3.3 System Operation and Performance

The initial injection of hydrogen peroxide was applied during February and March of 2000, with the first round of groundwater monitoring completed on March 16, 2000. The second and final injection event was completed during May and June of 2000. Approximately 20,000 gallons of 3% hydrogen peroxide solution was piped into the infiltration gallery during the two treatment events. Groundwater sampling was conducted on July 6, 2000 and again on February 14, 2001. Three bench tests conducted in 2001 demonstrated 95% effectiveness with site iron concentrations and 3% peroxide concentration. The analytical results for dissolved phase and total arsenic in groundwater are provided in Table 2-2.

3.4 Operation and Maintenance

3.4.1 Pentachlorophenol Groundwater Monitoring

Once operational, the *in situ* ozone sparge system was automated. Regular site visits were made to monitor the ozone system and make necessary adjustments.

Groundwater monitoring and sampling were conducted on a quarterly basis after the system startup and continued periodically as needed. Selected groundwater monitoring wells were monitored for depth to water and dissolved oxygen content. Depending upon the contaminant plume, groundwater samples from select wells were analyzed for PCP (see Table 3-1).

Groundwater results from 2000 to May 13, 2003 indicated the PCP concentrations in all affected wells reduced to non-detectable levels (see Section 3.3.3). However, results from the sampling event conducted on September 15, 2003 indicated that the PCP concentration in monitoring well MW-13 had rebounded to 38 μg/L. PCP concentrations in monitoring well MW-13 fluctuated slightly until the sampling event on June 14, 2005, when the concentration was below the laboratory reporting limit. Additionally, PCP concentrations periodically fluctuated in monitoring well MW-7S.

Groundwater samples collected on June 14, 2005 suggested that remediation was nearing completion with respect to the PCP groundwater plume. In response, Shaw proposed compliance monitoring at selected monitoring wells for a period of four consecutive quarters. On September 30, 2005, Shaw prepared a post-remediation groundwater sampling plan detailing the approach associated with PCP in groundwater at the subject site. At that time, the system had been running for approximately 4 years and had been successful in reducing PCP concentrations in groundwater to below the MTCA cleanup level of 7.29 µg/L in all locations at the site.

Assuming completion of four consecutive quarters of groundwater monitoring with results below the MTCA cleanup level, Shaw proposed to generate and submit a summary report indicating that compliance monitoring within the original treatment zone and the area in the vicinity of MW-7s was complete. Quarterly sampling events were set for October 2005, January 2006, April 2006, and July 2006.

The initial round of the groundwater compliance sampling was conducted on October 12, 2005. Groundwater samples were collected from all shallow monitoring wells that historically were sampled for PCP, including monitoring wells MW1S, MW-2S, MW-4S through MW-7S, MW-10 through MW-14, MW-16, and MW-17. Based on the analytical results of the initial compliance sampling event, a determination was made that after the initial round of sampling, groundwater samples would not be collected from wells that had never had PCP concentrations exceeding the MTCA cleanup level.

During the following two sampling events completed on January 17 and April 19, 2006, groundwater samples were collected from MW-2S, MW-6S, MW-7S, and MW-10 through MW-14. Rebounding to concentrations exceeding the MTCA cleanup level was observed in monitoring well MW-7S during the April 19, 2006 groundwater sampling event. The same effects were observed on May 17, 2006 when an additional groundwater sample was collected from MW-7S.

On July 26, 2006, samples were again collected from MW-2S, MW-6S, MW-7S, and MW-10 through MW-14, with a rebounding concentration in excess of the MTCA cleanup level observed in monitoring well MW-13. The same effects were observed on August 25, 2006, when an additional groundwater sample was collected from MW-13.

Modifications to the system were completed in June and September of 2006. The modifications were made in response to rebounding concentrations of PCP in monitoring wells MW-7S and MW-13 and required the installation of stinger probes from the existing ozone injection field.

The modifications made in June of 2006 were in response to the spike PCP concentration in monitoring well MW-7S. Several lengths of stainless steel piping from the ozone injection field were removed and rerouted to monitoring well MW-7S. An ozone injection stinger was lengthened and installed, and maintenance was performed on electrical connections in the ozone generator. The system was restarted with weekly operation and maintenance checks scheduled until the system was observed to operate properly.

Modifications to the remedial system in September were in response to a spike PCP concentration in monitoring well MW-13. The system was modified from its original layout by installing a "T" fitting between MW-7S and MW-13 to enable the installation and use of a stinger in MW-13. Maintenance was performed on electrical connections in the ozone generator, and the system was restarted with weekly operation and maintenance checks scheduled until the system was observed to operate properly.

The most recent sampling round completed on June 21, 2007 again indicated rebounding effects, with MW-13 yielding an analytical concentration of 569 µg/L, and the majority of wells yielding detectable concentrations. The analytical results for PCP prior to in situ ozonation up to the most recent groundwater sampling event conducted on June 21, 2007 are provided in **Table 3-1.** Additional constituents typically observed as by-products of dissolved phase PCP impact are listed in **Table 3-2.**

3.4.2 Arsenic

Once the hydrogen peroxide was added to the subsurface, no additional operational adjustment were necessary. A supplemental site investigation for arsenic was conducted in July 2003 and is discussed in Section 4.0.

4.0 Supplemental Site Investigation in 2003

The following sections describe investigation activities conducted at the site in July 2003 to further characterize arsenic-impacted soil and groundwater at the site. Work performed included the installation of additional monitoring wells, soil sampling, and groundwater sampling of new and existing monitoring wells.

4.1 Purpose

The purpose of this investigation was to better define the extent of arsenic impact to soil and groundwater at the site, and potentially determine if the source of the impact is from an on site or off site source.

4.2 Soil Boring and Monitoring Well Installation

Shaw installed six additional groundwater monitoring wells (designated MW-22 through MW-27) screened within the shallow aquifer on July 22, 2003. The locations of these additional and existing monitoring wells are presented in Figure 2-2. Monitoring well MW-22 was installed approximately 130 feet northwest of monitoring well MW-21. Monitoring wells MW-23 and MW-24 were installed in the southwestern portion of the property approximately 180 and 80 feet west of monitoring wells MW-21 and MW-20, respectively. Monitoring wells MW-25 through MW-27 were installed near the southern property boundary along the north edge of Terminal 115 North Access Road. Two of these wells (MW-25 and MW-26) were situated south of existing monitoring wells MW-3s and MW-18, and the third (MW-27) was installed southeast of the fenced portion of the site. The monitoring well locations were selected in areas where previous investigations failed to collect adequate data to delineate the arsenic-related concentrations in soil and/or groundwater.

A hollow-stem auger drill rig equipped with 8-inch outside-diameter augers was used to advance each shallow boring to a depth of approximately 15 feet bgs. Soil samples were collected, at a minimum, every 5 feet in depth and logged by a Shaw geologist. Monitoring wells installed in the borings were constructed of 2-inch diameter polyvinyl chloride (PVC) casing and 0.020-inch machine slotted screen. The well screen for each of the wells was installed from approximately 5 to 15 feet bgs (the bottom of the well screens extended approximately 2 feet into the silt layer). The annular space of each boring was filled with #2/12 Monterey sand from the total depth of the well to approximately 1 foot above the top of the screen. Hydrated bentonite chips were used to seal each well from 3 to 4 feet bgs. Each well was completed at the surface with a flush-mount, traffic-rated well vault encased in concrete to a depth of 3 feet bgs. Boring logs and well construction details are included as **Appendix B**.

After completion of well installation, the monitoring wells were developed using a surge block, bailer, and a centrifugal pump, which was used to remove approximately five well casing volumes or until water quality parameters (pH, conductivity, dissolved oxygen, oxidation reduction potential, temperature, and turbidity) stabilized.

Soil drill cuttings, drilling decontamination water, and well development water were containerized in Department of Transportation approved 55-gallon drums, labeled, and stored on site awaiting proper disposal.

4.2.1 Soil Sampling

Soil samples were collected via a split spoon sampler driven by a 140-pound hammer. Soil samples collected during monitoring well drilling activities were stored in laboratory-supplied containers, placed in chilled coolers, and submitted to CCI Analytical Laboratories, Inc., in Everett, Washington for analysis under proper chain of custody procedures. Samples were analyzed for arsenic by U.S. Environmental Protection Agency (EPA) 6000/7000 series methods. Soil samples submitted for analyses were selected based on field observations, groundwater level, and/or changes in lithology.

4.2.2 Groundwater Sampling

On July 29 groundwater samples were collected from each of the new monitoring wells, as well as existing monitoring wells MW-2S through MW-4S, MW-6S, MW-10 through MW-14, MW-17 through MW-21, MW-2D, and MW-3D. Prior to sampling, each well was purged using low-flow purging techniques. Water quality parameters (temperature, pH, dissolved oxygen, specific conductivity, and oxidation-reduction potential) were recorded every five minutes until each parameter stabilized as described in the EPA low flow purging and sampling protocol. The samples were stored in laboratory-supplied containers, placed in chilled coolers, and submitted to CCI Analytical Laboratories, Inc., in Everett, Washington for analysis under proper chain of custody procedures. Samples were analyzed for arsenic by U.S. Environmental Protection Agency (EPA) 6000/7000 series methods. Analytical results are described in Section 4.3 below.

On September 8, 2003, Shaw personnel collected groundwater level data from all existing monitoring wells at the site. At the same time, Allied Surveying surveyed top of casing elevations on all monitoring wells at the site and referenced them to a City of Seattle elevation benchmark. **Table 4-1** provides groundwater elevations for monitoring wells at the site as recorded on September 8, 2003. Approximate groundwater elevation contours are shown on **Figure 4-1**. Based on these measurements, at the time the measurements were taken, groundwater flow direction at the site was generally to the southeast with an approximate gradient of 0.007 feet per foot.

4.3 Laboratory Results

The following section describes the results of sampling for soil and groundwater in July 2003. The results are incorporated with the previous findings and a current understanding of the extent of arsenic impact to soil and groundwater is presented. Laboratory analytical data for soil and groundwater samples are included in **Appendices C** and **D,** respectively.

4.3.1 Soil

Based on previous investigations performed by RETEC, elevated arsenic concentrations in site soil was believed to be located predominantly in the southeastern portion of the site. However, based on results from the 2003 investigation, arsenic was found at elevated concentrations farther to the northwest than previously identified. **Table 4-2** presents the analytical data for arsenic in soil reported for samples collected during the 2003 investigation.

A soil sample collected from the boring for monitoring well MW-22 at 5 to 5.5 feet bgs contained an arsenic concentration of 160 mg/kg. Soil samples collected along the southern property boundary correlated well with previous results from the southern area of the site; however, based on elevated concentrations near the property boundary, it appears that contaminated soils may also be present off site. Arsenic concentrations of 180 mg/kg at 5.0 to 5.5 feet bgs and 250 mg/kg at 10.5 to 11.0 feet bgs were reported in soil samples collected from the MW-26 soil boring, located to the southeast of monitoring wells MW-3s and -3d (an arsenic concentration of 320 mg/kg was previously identified east of MW-3s/d). Another soil sample collected within the saturated zone (10.5 to 11 feet bgs interval) from the boring of monitoring well MW-26 had an arsenic concentration of 250 mg/kg.

Concentrations of arsenic in soil from all the other soil samples collected from MW-23 through MW-25 and MW-27 ranged from non-detect to 11 mg/kg. **Figure 4-2** present the soil analytical data from the 2003 sampling event.

4.3.2 Groundwater

Based on results of previous investigations, the locations of the newly installed wells were selected to delineate the arsenic-related concentrations in groundwater. **Table 2-2** presents the analytical results from the July 2003 groundwater sampling event. **Figure 4-3** presents the arsenic isoconcentration contours from the July 2003 event. Additionally, **Figure 4-3** presents the original anticipated area of impact and injection system design area for treatment of arsenic impacted groundwater at the site. The highest arsenic concentrations in groundwater were present along the southern boundary of the site (monitoring well MW-25 had an arsenic concentration in groundwater of 1,100 µg/L).

5.0 Current Understanding of Site Characteristics

A description of the current site characteristics is developed in this section to guide the future site activities. As such, this section describes the current understanding of potential sources and site characteristics, geochemical properties and constituent movement pathways, and exposure pathway completeness.

5.1 Site Land Use

The current land use is industrial. The site is owned by Glacier, which operates a cement and aggregate terminal. The site is currently covered with gravel and crushed rock and is being used for vehicle parking and staging associated with the batch plant operation. Future land use will remain industrial.

5.2 Potential Source Areas

The RI identified two distinct on-site source areas where PCP was detected in soil and groundwater and FD-GTI developed a remediation system to treat the soils in these areas. The in situ ozonation treatment underwent start-up and shakedown in March and April, 2000 and was fully online in June 2000. The system operated almost continuously for approximately 6 years, and during that time, groundwater samples were collected and analyzed for PCP to assess changes in concentrations in groundwater in the two treatment areas.

Based on soil and groundwater sampling by RETEC, the southern portion of the site was identified as the area with the greatest concentrations of arsenic in soil and groundwater. Onsite historic activities associated with Reichhold and Glacier operations are well documented and did not involve the use of arsenic. Therefore, the area-wide distribution of arsenic concentrations is most likely a fill issue. Additional off-site sources may be attributable to the adjacent industrial operations to the north (e.g., Duwamish Shipyard) and south (e.g., MRI Corp.) of the site.

5.2.1 Pentachlorophenol Presence in Groundwater

Since the treatment system commenced operation in April/June 2000, 20 groundwater sampling events have been conducted to assess the concentration of PCP in the site's 14 groundwater monitoring wells. **Figure 5-1** presents the post-treatment groundwater contours for PCP.

5.2.1.1 North Source Area for PCP

Three groundwater monitoring wells (MW-4S, MW-7S and MW-16) were monitored to assess PCP in the shallow groundwater near the north source area. The initial concentration of PCP at

MW-4S and MW-7S on April 18, 1996 was 300 µg/L and 310 µg/L, respectively. After treatment, the concentration of PCP in groundwater monitoring well MW-4S in the one sampling event on October 12, 2005 was less than the method reporting limit of 0.481 µg/L. After the treatment system was turned off to begin compliance monitoring, the concentration of pentachlorophenol in groundwater monitoring well MW-7S spiked in two sampling events in April and May 2006 (73.4 µg/L and 90 µg/L, respectively). The remediation system was turned back on and groundwater concentrations were reported at or near the respective method reporting limits in the last two sampling events on July 26, 2006 and June 21, 2007 (<0.962 µg/L and 1.18 µg/L, respectively). A groundwater sample collected on October 12, 2005 from monitoring well MW-16 had a concentration of pentachlorophenol of 1.58 µg/L.

Based on the concentrations of pentachlorophenol in groundwater samples collected from three monitoring wells in the north source area from the latest sampling events, it appears that the treatment system effectively reduced pentachlorophenol from a peak of 304 µg/L before treatment to concentrations less than 2 µg/L after treatment.

5.2.1.2 Former Impoundment Source Area for PCP

Shallow groundwater monitoring wells MW-2S and MW-13 were monitored to assess pentachlorophenol in groundwater in the former wastewater impoundment area. Three other shallow groundwater monitoring wells (MW-10, MW-11 and MW-12) located northwest and within approximately 50 feet of the former impoundment were also monitored. Prior to commencement of treatment, pentachlorophenol concentrations in shallow groundwater ranged from 42 µg/L in MW-2S (December 1995) to 8,040 µg/L in MW-13 (November 1998). After 14 sampling events of MW-13, where pentachlorophenol concentrations were less than 50 µg/L, the last three sampling events experienced spikes up to 569 µg/L in June 2007. The four other shallow groundwater monitoring wells in this area have had pentachlorophenol concentrations at or near the respective method reporting limit (less than 2 µg/L) during the last five sampling events from October 2005 to June 2007.

Based on the concentrations of pentachlorophenol in groundwater samples collected from five monitoring wells in the area of the former impoundment, it appears that the treatment system effectively reduced pentachlorophenol from a peak of 63.2 µg/L before treatment to concentrations less than 2 µg/L in 4 of the 5 groundwater monitoring wells. This is consistent with the one order of magnitude reduction in pentachlorophenol concentrations in water samples collected in monitoring well MW-13 before and after treatment (3,410 µg/L to 8,040 µg/L before treatment and 267 µg/L to 569 µg/L after treatment).

5.2.2 Arsenic Presence in Soil

Soil sampling has been conducted using test pits, Geoprobe™ borings, and hollow-stem auger drill rig borings during the installation of site monitoring wells. At the time of remediation activities from 1998 to 2000, the MTCA Method A cleanup level for arsenic in soil was 200 mg/kg, while the current cleanup level is 20 mg/kg. This value is presented for discussion purposes only and is not intended to be proposed as the site-specific cleanup level.

A soil sample collected from 8.5 to 9 feet bgs in the soil boring of MW-24 had an arsenic concentration below the method reporting limit (4 mg/kg). Arsenic in soil was detected in MW-22, which is located northeast of the original treatment area, at a concentration of 160 mg/kg from a depth of 5 feet bgs. Soil samples from MW-26, located in the southeast corner of the site outside the fence boundary, indicated arsenic at concentrations of 180 and 250 mg/kg at depths of 5 and 13 feet bgs, respectively. Another soil sample collected from 8 to 8.5 feet bgs in the soil boring of MW-26 had an arsenic concentration of 9.1 mg/kg. These locations are outside the zone of influence of the original treatment area.

5.2.3 Arsenic Presence in Groundwater

Periodic groundwater sampling has been conducted in select monitoring wells on-site since 1995. The MTCA Method A cleanup level for arsenic in groundwater is 5 μg/L. The following explanation of the extent of arsenic contamination in groundwater is based on the MTCA Method A cleanup level. This guidance value is presented for discussion purposes only and is not intended to be proposed as the site-specific cleanup level.

The estimated lateral extent of arsenic-impacted shallow groundwater, based on the groundwater samples collected in July 2003, is presented in **Figure 4-3**. Arsenic has been detected in the deeper aquifer identified in the RI. However, the RI concluded that the silt layer separating the two water bearing zones is an effective barrier to downward migration. The top of the silt layer is located at a depth of 9 to 13 feet bgs.

Six shallow groundwater monitoring wells located within the treatment zone and installed prior to the 2000 treatments have been periodically sampled to assess the concentration of total and/or dissolved arsenic in the treatment zone. The RI March 1996 sampling event detected dissolved arsenic in the southern portion of the property ranging from 500 to 7,400 μg/L. Subsequent groundwater monitoring in March 1999 through March 2000 verified the presence of dissolved arsenic in groundwater in the southern source area at concentrations up to 7,350 μg/L (see Table 2-2).

Following the two hydrogen peroxide treatment episodes in February/March 2000 and July/August 2000, groundwater monitoring wells located in the treatment zone showed significant reductions in dissolved arsenic. For example, groundwater samples collected from monitoring wells MW-14, MW-17 and MW-20 and had a 2-order of magnitude reduction in dissolved arsenic concentrations and wells MW-3s and MW-21 had 1-order of magnitude reduction in dissolved arsenic concentrations after treatment. Based on the groundwater sampling data, it is apparent that the hydrogen peroxide treatment was effective in reducing dissolved arsenic in the southern portion of the site within the treatment area of influence. **Table 5-1** provides a comparison of pre-remediation vs. post-remediation dissolved arsenic concentrations in groundwater.

Although there were large reductions in dissolved arsenic concentrations in groundwater samples collected from monitoring wells located in the treatment area of influence after treatment, the concentrations of dissolved arsenic in samples collected from groundwater monitoring wells in July 2003 ranged from 28 μg/L to 190 μg/L. The highest dissolved arsenic concentration collected after both treatment episodes (1,100 μg/L) was from monitoring MW-25, located on the southern property boundary adjacent to Terminal 115 N Access Rd. and outside the treatment area of influence.

5.3 Physical Properties of COPCs

5.3.1 Pentachlorophenol

The main anaerobic biodegradative pathway for PCP is reductive dehalogenation. In this process, the compound PCP is broken down to tetra-, tri-, di- and mono-chlorophenols and phenol, which then eventually completely decomposes to water and carbon dioxide or methane. Chloride and hydrogen ions are released at each of the dehalogenation steps. Another pathway is methylation to pentachloroanisole (a more lipid soluble compound); which also eventually leads to complete degradation.

In aerobic degradation pathways, the phenol ring is broken during an early stage of the process. Intermediate products that may form prior to breaking the phenol ring may include tetrachloroatechol, tetrachlorohydroquinone, tetrachlorobenzoquinone, and trichlorohydroxylbenzoquinone (Mahaffey 1997).

In reductive soil and sediments, PCP can be degraded within 14 days to 5 years, depending on the redox conditions, nutrient and organic carbon concentrations, and the anaerobic soil bacteria that are present. However, the adsorption or mobility of pentachlorophenol in soils is controlled primarily by soil pH. Adsorption decreases in neutral and basic soils and is strongest in acidic soils. Therefore, the compound is most mobile in neutral-to-basic mineral soils and least mobile in acidic organic soils. Pentachlorophenol is readily adsorbed to soil or sediment under acidic conditions, but tends to be mobile under neutral or alkaline conditions (ATSDR, 2001). The amount of pentachlorophenol adsorbed at a given pH also increases with increasing organic content of the soil.

Rebound of PCP groundwater concentrations in response to in situ chemical oxidation is a common observation at sites where these methods have been applied. The rebound is due to the adsorption/desorption behavior of the compound in an aquifer. Under chemical equilibrium conditions, some fraction of the total mass of the compound that is present in a given volume of aquifer will be in an adsorbed state, and the remaining fraction will be dissolved in the groundwater. The equilibrium ratio of the adsorbed mass to the dissolved mass is described by the adsorption coefficient (K_d), which is a function of a number of compound-related and site-specific parameters.

Organic contaminants such as PCP preferentially adsorb on naturally occurring solid organic material that is present in the aquifer matrix. The organic carbon adsorption coefficient (K_{oc}) is used to express the distribution of a contaminant between the mass adsorbed on pure organic carbon versus the mass that is dissolved. A K_d can be calculated from the K_{OC} by multiplying the K_{OC} for a compound by the site-specific fraction of organic carbon (f_{OC}) that is present in the aquifer, or

$$K_d = K_{OC} \text{ x } f_{OC}.$$

EPA (1996) provides experimentally determined $log\ K_{OC}$ values for PCP as a function of pH. A $log\ K_{OC}$ of 2.94 is given for a pH of 6.4. If one assumes that the aquifer matrix contains between one and ten percent organic carbon and a pH of 6.4, then there will be between nine and ninety times more PCP present in the adsorbed state relative to the dissolved state in the aquifer.

The injection of hydrogen peroxide or ozone preferentially oxidizes the dissolved fraction of PCP. The sudden decrease in the dissolved PCP concentration creates a disequilibrium in the ratio of adsorbed-to-dissolved mass. The system will respond by slowly desorbing additional PCP from the sediments into the groundwater so that the equilibrium K_d ratio is maintained. The rate of oxidation of the dissolved PCP in response to in situ oxidation is faster than the rate of desorption, so a decrease followed by a rebound in dissolved PCP concentrations may be observed after an in situ oxidation event, even though some PCP mass was destroyed. Repeated injections of oxidants may lead to additional decreases followed by rebounds in dissolved concentrations until both the adsorbed and dissolved fractions of the compound are completely oxidized.

5.3.2 Arsenic

Arsenic concentrations in groundwater are mostly controlled by adsorption-desorption ("sorption") reactions on aquifer mineral surfaces and the surfaces of suspended particulates. Key factors that affect the sorption of arsenic on these fixed and mobile surfaces are local redox and pH conditions, and the concentrations of competing anions such as sulfate and phosphate.

Arsenic exists in groundwater as one or more soluble aqueous species or as suspended particulates, depending on the local redox conditions in the aquifer. Generally this can be summarized as the following:

- Oxidizing Conditions – Arsenic is present in the pentavalent redox state (As V, or *arsenate*), and exists in solution as the oxyanion species $H_2AsO_4^-$, or $HAsO_4^{2-}$, depending on pH. These species have a strong affinity to adsorb on iron oxide surfaces, which limits its mobility as long as the pH is in the range of about 5 to 8.5. Detectable concentrations of arsenic under these redox and pH conditions in unfiltered groundwater samples is usually due to the presence of suspended iron oxide particulates to which the arsenic is adsorbed. If arsenic is present as suspended particulates, then a decrease in concentration is expected in a filtered sample relative to the concentration in an unfiltered sample. This can be identified by a low (< 1) filtered/unfiltered ratio.
- Intermediate Redox Conditions – Arsenic is present in the trivalent redox state (As III, or *arsenite*), and exists in solution as the neutrally charged oxy form $HAsO_2^o$ or the hydroxide form $As(OH)_3^o$, depending on pH. These species do not strongly adsorb on mineral surfaces because of their neutral charges so they can be quite mobile. Arsenic present in these forms are not removable by filtration, so a filtered and unfiltered split will have similar concentrations. This can be identified by a filtered/unfiltered ratio that is close to unity.
- Highly Reducing Conditions – If reducing conditions are present, sulfate-reducing anaerobes are active, and there is a source of sulfate, then arsenic will react with sulfide produced by the anaerobes, and will precipitate as one or more sulfide minerals such as orpiment (As_2S_3), realgar (AsS), or arsenic-iron sulfide minerals such as arsenopyrite (FeAsS). These minerals have very low solubilities, which can significantly limit arsenic mobility as long as conditions remain reducing. However, if oxidizing conditions return, then the sulfide minerals will react with oxygen to form sulfuric acid, and the arsenic will be released to solution. If intermediate redox conditions are maintained at that point, then the arsenic will remain mobile, but if oxic conditions prevail, then the iron released from

the sulfides will precipitate as oxides upon which the arsenate will adsorb. Cyclic changes in redox conditions can thus induce reversible changes in arsenic mobility.

In addition to changes in redox and pH, arsenic mobility can be affected by the concentration of various ions in groundwater. Specifically, anions such as sulfate and phosphate will compete with arsenate for sorption sites and can displace adsorbed arsenate.

The color of the sands and silts encountered during the RI generally ranged from gray to black. These colors are usually indicative of a reducing environment. In general, a reducing environment would have the effect of promoting the natural degradation of pentachlorophenol via anaerobic pathways, but would also elevate the concentration of arsenic that is dissolved in the groundwater. An exception would be if strongly anaerobic sulfate-reducing conditions exist, in which case arsenic may precipitate as low-solubility sulfide minerals. Additional site-specific information regarding redox conditions is discussed below.

5.3.2.1 Filtered vs. Unfiltered Samples

The intent of filtration is to remove suspended particulates; however, there is no specific filter size that effectively separates solutes that are present as suspended particulates from solutes that are in true solution. The diameters of suspended particulates form a continuum of values that can range from 100 microns to 0.001 micron, depending on the shape and charge of the particulates (Stumm and Morgan, 1996). The use of a standard 0.45-micron pore size filter, which is roughly in the middle of the range of suspended particulates, could thus allow a significant fraction of the finer range of particulates to pass if they are present in the sample. Despite these limitations, comparisons of the concentrations of an element in filtered versus unfiltered splits of samples are still useful in determining if the majority of the detected element is present in solution or as suspended particulate form. If a trace element is mostly present in particulate form, then some reduction in concentration should be observed after filtration, although some very fine particulates may remain in the sample (Thorbjornsen and Myers, 2007 and 2008).

5.3.2.2 Relationship Between Arsenic and Iron

Arsenic concentrations are dominantly controlled by adsorption on iron oxides, so the fate of arsenic is closely related to the behavior of iron. Iron is also strongly affected by redox conditions. Under oxidizing conditions iron is present in the ferric (Fe^{3+}) form, and will precipitate as oxide or hydroxide minerals that have very low solubilities. Detections of iron in oxic groundwater samples are usually due to the presence of suspended iron oxide particulates. Filtration of the samples will remove some or all of the iron, yielding low (< 1) filtered/unfiltered ratios.

If the redox potential drops below a critical value, then the ferric iron will reduce to ferrous iron (Fe^{2+}) iron, which is soluble. Iron oxide minerals will dissolve under these conditions, yielding high concentrations in the filtered splits, and result in filtered/unfiltered ratios close to unity. Filtered/unfiltered iron ratios thus provide an effective redox indicator.

The kinetics of arsenic and iron redox reactions are fully reversible and are relatively fast. Iron responds to changes in redox on a time scale of hours to days, and arsenic responds on a time scale of days to weeks. Cyclic changes in redox conditions at a site on a scale of weeks to months, induced by either natural seasonal variations or by active remediation, should induce measurable changes in arsenic and iron behavior.

5.3.3 Evaluation of E[illegible] g Data

Arsenic concentrations in [illegible]tered and unfiltered splits were analyzed in four rounds of samples obtained on 4/21/1999, [illegible]/1999, 3/16/2000, and 7/6/2000. These data are summarized in **Table 5-2**. Between 9 [illegible]d 12 samples were obtained each round. Samples from two of the four rounds were also analyzed for iron in filtered and unfiltered splits. The data from the four rounds shows clear evidence of redox cycling in response to the episodic ozone and hydrogen peroxide injections, and seasonal recharge influence, as discussed below.

5.3.3.1 Arsenic Filtered/Unfiltered Ratios

The arsenic filtered/unfiltered ratios for the four rounds of samples from each well are shown in **Figure 5-2**. All of the samples from the 4/21/1999 and 3/16/2000 rounds show consistently high filtered/unfiltered arsenic ratios, indicating reducing conditions. The 4/21/1999 ratios range from 0.76 to 1.5, with a mean of 0.98; and the 3/16/2000 ratios range from 0.64 to 1.7, with a mean of 1.04. These ratios, which center around unity, indicate that the redox conditions are reducing, and the arsenic is present in the soluble trivalent state.

All of the 11 samples from the 8/12/1999 sample round consistently show much lower filtered/unfiltered ratios, as seen on **Figure 5-2**. These ratios range from 0.004 to 0.35, with a mean of 0.10. These low ratios indicate oxidizing conditions under which the arsenic is present in the pentavalent state and is mostly adsorbed on the surfaces of suspended iron oxides which are partially removable by filtration.

The 11 samples obtained on 7/6/2000 show a broad range of ratios (0.08 to 1.07) over the sampled area, indicating a redox gradient across the site. This could be due to the site transitioning between redox states in response to the end of the hydrogen peroxide injections or the start of the ozone treatment system. Seasonal influences may also be contributing to the redox cycling.

5.3.3.2 Iron Filtered/Unfiltered Ratios

Samples from the 8/12/1999 and 7/6/2000 events were analyzed for iron as well as arsenic in the filtered and unfiltered splits. These data are summarized in **Table 5-3**. The iron filtered/unfiltered ratios for these two rounds of samples from each well are shown in **Figure 5-3**. These ratios show a remarkable similarity to the arsenic ratios shown in **Figure 5-2**, and provide independent evidence for redox cycling at the site. The 11 samples obtained on 8/12/1999 all show very low (0.003 to 0.17) filtered/unfiltered iron ratios, as was the case for arsenic. The iron ratios from the 7/6/2000 sample event show an almost identical transition pattern as displayed by the arsenic ratios, which can be seen by comparing the data from this sample event in Figures 5-2 and 5-3, thus confirming that a redox gradient existed at the site at this point in time.

5.3.3.3 Arsenic Concentrations in Filtered Samples

The concentrations of arsenic in filtered samples from the four sampling events are shown in **Figure 5-4**. Note that a logarithmic scale is used for the vertical concentration axis so that the full range of concentrations can be clearly seen. The figure shows that oxidizing conditions, which prevailed during the 8/12/1999 sample event, results in arsenic concentrations that are in some cases over an order of magnitude lower than the concentrations under reducing conditions. This cycling of arsenic concentrations is expected because arsenic tends to adsorb on iron oxide surfaces under oxidizing conditions, but is more mobile under reducing conditions as explained in the section above.

5.3.4 Arsenic Summary

Temporal variations in the filtered/unfiltered ratios for arsenic and iron, and the absolute arsenic concentrations in filtered samples, provide three independent lines of evidence for redox cycling at the site. A conceptual geochemical model for arsenic behavior at the site can be developed from these observations as follows:

1. The sampled shallow water-bearing unit underlying the site is naturally reducing, so naturally occurring arsenic plus additional sources of arsenic (e.g., fill or dredge material)

is dominantly present in the soluble and mobile trivalent form under undisturbed conditions.

2. The episodic addition of ozone or hydrogen peroxide from the active remediation system causes a series of reactions to occur. Initially, dissolved ferrous iron will rapidly oxidize to ferric iron and precipitate as a ferric oxyhydroxide (FeO•OH) or hydroxide [$Fe(OH)_3$]. Dissolved trivalent arsenic will slowly oxidize to the pentavalent form and will adsorb on the surfaces of the freshly precipitated iron minerals. These reactions will lower the dissolved arsenic and iron concentrations.
3. Cessation of peroxide or ozone injections, as well as seasonal influences, allow the aquifer to return to reducing conditions. As the redox falls below a threshold value, the precipitated iron minerals will redissolve, and the adsorbed pentavalent arsenic will revert back to the mobile trivalent form.

5.4 Review of Potential Source Areas of Arsenic

Arsenic is a naturally occurring metal in the environment and varies in concentrations across geographic regions. In addition to naturally occurring levels of arsenic in site soils, this section provides a discussion of additional anthropogenic sources that may be contributing to the varied distribution of soil concentrations at the site.

5.4.1 River Channel, Site Fill, and Site Grading Activities

One of the most likely sources of arsenic is from materials that may have been used for filling and grading the site during development in the late 1940s and filling in the historic river channel in the 1960s. Based on maps of the historic river channel and aerial photographs, the majority of the current shoreline at the site appears to have been the original/historic shoreline of the river meander; however, land immediately south of the site (and potentially including the south end of the site) was formerly part of the river channel. If materials used for filling this area of the channel were contaminated with arsenic, this could explain why arsenic concentrations are highest at the south end of the site.

Historical records and subsurface investigations at the site have identified fill materials across the site. Similar to the river fill, contaminated fill may have been deposited directly onto the site during historic grading activities. The general practices of that time indicate that dredge materials from the Duwamish were typically used as fill material. These sediments could potentially have been impacted with arsenic prior to dredging and deposition onto the site.

5.4.2 State-Wide Arsenic Contamination

Large areas of Washington State have elevated levels of arsenic (and lead) in soil from three historical sources: air emissions from metal smelters, lead arsenate pesticides, and combustion of leaded gasoline. Other sources of arsenic contamination include wood treated with chromated copper arsenate (often called "pressure-treated" wood), emissions from coal-fired power plants and incinerators, and other industrial processes.

A multi-agency chartered panel called the Area-Wide Soil Contamination Task Force (Task Force) was charged with developing findings and recommendations related to large areas of low- to moderate-level arsenic and lead soil contamination (so called "area-wide soil contamination") in Washington State. The Task Force published their findings in a report titled *Area-Wide Soil Contamination Task Force Final Report* (Task Force, 2003). According to the Task Force Report, "area-wide soil contamination" refers to low- to moderate-level soil contamination that is dispersed over a large geographic area, covering several hundred acres to many square miles. For schools, childcare centers, and residential land uses, in general, Ecology considers total arsenic concentrations of up to 100 milligrams per kilogram (mg/kg) to be within the low-to-moderate range. For properties where exposure of children is less likely or less frequent, such as commercial properties, parks, and camps, Ecology considers total arsenic concentrations of up to 200 mg/kg to be within the low-to-moderate range.

The Task Force considered area-wide arsenic and lead soil contamination primarily from two sources: past use of lead arsenate-based pesticides, and historical emissions from metal smelters located in Everett, Northport, Tacoma, and on Harbor Island (in Seattle). The study found that approximately 487,000 acres in Washington State has been affected by the smelters. The Task Force also considered the possibility of area-wide soil contamination from combustion of leaded gasoline, and made recommendations about gathering additional information on the potential for area-wide soil contamination from this source.

According Task Force Report, the range of concentrations of arsenic in soil associated with area-wide soil contamination is quite broad. Total arsenic concentrations range from natural background levels (7-9 mg/kg statewide) to over 3,000 mg/kg in smelter areas. Average concentrations of total arsenic in soil at developed properties with area-wide soil contamination generally are less than 100 mg/kg. By comparison, the MTCA soil cleanup levels for unrestricted land use for total arsenic is 20 mg/kg. Soil concentrations tend to be greater around the Tacoma smelter than in the other smelter areas, because the Tacoma smelter operated for a longer period and specialized in the processing of high-arsenic ore.

As indicated on **Figure 5-5,** the site is located within the estimated area-wide impacted plume from the Tacoma Smelter Site. It is possible that during filling of the site, highly impacted surface soils from within the 'area-wide soil contamination' plume were mixed with underlying site soils and redistributed throughout the site. Thus, these mixing and filling activities at the site may provide a partial explanation for the varied and unpredictable arsenic concentration patterns in soil.

6.0 Summary and Recommended Actions

Glacier and Reichhold have been pursuing an active voluntary cleanup of the site since the mid-1990s. The 1996 RI evaluated past operations at the site and concluded that there were two COPCs: pentachlorophenol and arsenic. The identified PCP source areas included the area south of the Second PCP Pilot Plant and the Former Impoundment Area. Although an original source of arsenic in soil and groundwater was inconclusive, the southern portion of the property was identified as an arsenic source area for remediation.

6.1 Remediation Activities

Based on the RI findings, FD-GTI developed a remedial action plan that called for ozone sparging of groundwater in the two PCP source areas. They also presented an approach for in-situ fixation to treat arsenic affected soils and groundwater in the southern portion of the property. The remediation was initiated in Spring/Summer 2000 and groundwater monitoring was conducted to assess concentrations of PCP and arsenic in groundwater. The ozone sparge system operated until post-treatment monitoring commenced on October 2005 for four quarters. Hydrogen peroxide injections to fixate arsenic were conducted in the southern portion of the property in February/March 2000 and July/August 2000.

6.1.1 Pentachlorophenol

Groundwater samples collected from groundwater monitoring wells located near the northern PCP source area decreased from 304 µg/L before treatment to near method reporting limit values up to 1.59 µg/L in the last 2 sampling episodes in July 2006 and June 2007.

In the former impoundment PCP source area, groundwater samples collected from monitoring well MW-10 decreased from a peak of 63 µg/L to near method reporting limit values up to 2 µg/L in the last 2 sampling episodes in July 2006 and June 2007. Pretreatment concentrations of PCP in MW-13 peaked at 8,040 µg/L and was reduced to 569 µg/L in the last sampling episode in June 2007. The spike in PCP concentrations during the most recent three sampling events followed three sampling events where the concentrations ranged from 0.606 µg/L to 5.12 µg/L after the treatment system was turned off. As discussed in Section 5.3, one factor likely contributing to the rebound of PCP is the slow desorption of the adsorbed fraction of PCP following in situ oxidation treatments.

6.1.2 Arsenic

After treatment of the southern source area, the concentration of dissolved arsenic in groundwater monitoring wells within the treated zone of influence has been reduced as much as two orders of magnitude when compared with pre-treatment concentrations. The dissolved arsenic concentrations reduced from 84 percent to 96 percent when pre-treatment concentrations were compared with post-treatment concentrations. However, the remaining dissolved arsenic concentrations in groundwater samples collected in 2003 ranged from 28 μg/L to 190 μg/L. In addition, groundwater monitoring well MW-25, installed and sampled in 2003, had a dissolved arsenic concentration of 1,100 μg/L. The following factors could have contributed to this high value:

- The well is located outside the estimated zone of influence.
- Other off site sources may be impacting this well since it is located along the southern property boundary.
- In-situ oxidation was effective in lowering arsenic concentrations, as long as oxidizing conditions prevail. However after the treatments stopped and the site reverted to reducing conditions, then the arsenic may remobilize.

An on-site source associated with Reichhold or Glacier past operations has not been identified. Based on site conditions, the potential arsenic-related source is fill from off-site areas.

6.2 Recommended Actions

The following summarizes the cleanup activities to date and provides the basis for the recommended actions going forward:

1. extensive characterization of soil and groundwater for the COPCs has been completed;
2. RI and FS documents have been prepared and submitted to Ecology;
3. remedial activities have been implemented for both arsenic and pentachlorophenol;
4. the remediation has substantially reduced the concentration of pentachlorophenol in groundwater as well as arsenic in groundwater;
5. pentachlorophenol or its breakdown products have not been detected in the seeps during 1995 or 2004 sampling; and

6. Arsenic concentrations were detected in unfiltered and filtered seep samples during the 1995 and 2004, respectively, sampling events.

Recommended actions are discussed below.

6.2.1 Develop Site-Specific/Risk-Based Cleanup Levels for Groundwater

The site is an industrial property located in a highly industrialized area of Seattle. The surface has been covered with crushed rock and there is no complete exposure pathway to soils or groundwater. Also, groundwater is not used as a potable drinking water source; therefore the groundwater ingestion pathway is not complete.

The shallow groundwater to surface water pathway is a potentially complete migration pathway at the site. However, seep data collected at the site indicated PCP is non-detect in the seeps. Arsenic has been detected in unfiltered and filtered seep samples during previous investigations. Therefore, site-specific groundwater cleanup levels should be developed for the site based on the migration to surface water pathway.

6.2.2 Groundwater Sampling

The ozone sparge remedial activities were effective in reducing the concentrations of PCP in groundwater. Groundwater sampling is needed to obtain the current conditions of the PCP in groundwater. If current groundwater concentrations are found to be below the cleanup level developed for the site, then a compliance monitoring program will be developed. Alternatively, if current groundwater concentrations are found to be above developed cleanup levels, then additional remedial options would be evaluated.

The in situ fixation remedial activities conducted for arsenic in the southern portion of the site also proved to be effective at reducing arsenic concentrations at the site. However, the supplemental subsurface investigation in 2003 indicated the presence of elevated arsenic concentrations in areas north of the treatment zone.

Based on the limited redox data available for evaluation, the conceptual geochemical model for arsenic suggests that the shallow water zone is naturally reducing. Before any additional discussions of extent and remedial options can be presented, additional data needs to be collected. On-site groundwater samples should be obtained from upgradient of the arsenic plume, within the arsenic plume, and between the plume and the Duwamish River. It is important to obtain samples from impacted as well as unimpacted areas so that the natural background redox conditions can be assessed.

Two quarters of groundwater sampling will be conducted to assess current conditions and collect the data for site-specific redox conditions and development of site-specific cleanup levels. The following data would be obtained during the collection and subsequent analysis of the groundwater samples:

- Field parameters: pH, DO, ORP, turbidity, and depth to water
- Metals: filtered and unfiltered (in the field) splits of samples for aluminum, arsenic, manganese, and iron (the filtered/unfiltered ratios of manganese and unfiltered iron/aluminum ratios are also sensitive indicators of redox conditions)
- Anions: sulfate, sulfide, nitrate, and phosphate
- Ferrous iron and sulfide measured in the field using field test kits. The field tests are qualitative but high accuracy is not needed for these parameters, and it avoids holding time problems with these analytes
- Pentachlorophenol.

In summary, the two near future recommended actions include:

1. Prepare and implement a Groundwater Sampling Plan
2. Development of site-specific cleanup levels for groundwater
3. Compare site-specific cleanup levels to site data

Reichhold and Glacier are committed to continuing remedial actions and working with Ecology under the Voluntary Cleanup Program to obtain site closure.

6.3 Report Limitations

Shaw's work product shall be for the use and evaluation of client only, and shall not be construed to be for the benefit of any third party. This work is not a complete analysis of site conditions and is being provided as-is.

In performing these services, Shaw has relied upon work and information provided by others but does not endorse the quality or accuracy of previous site characterizations preformed by others. Notwithstanding anything to the contrary in any contract or amendments thereto, Shaw does not guarantee any work and information by third parties. **All express, implied and statutory warranties are expressly disclaimed to the fullest extent permitted by law.** Shaw shall have no responsibility for determining the suitability of this work or for the operations conducted by the Client or any third party at the site.

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Tables

Table 2-1
Soil Analytical Results for Arsenic & PCP: 1998
Reichhold/Glacier Site
Seattle, Washington

Well ID	Sample Date	Sample Depth (ft bgs)	Arsenic (mg/kg)	PCP (mg/kg)
MW-10	10/13/1998	5.5-6.5	15.2	1.92
		10-10.5	12	0.333
MW-11	10/13/1998	5.5-6.5	6.86	1.58
		10-10.5	11.7	0.0709
MW-12	10/13/1998	5.5-6.5	4.69	<0.05
		11-11.5	26.5	<0.05
MW-13	10/13/1998	5.5-6.5	182	<0.05
		11-11.5	216	4.4
MW-14	10/13/1998	5.5-6.5	103	NA
		10.5-11.5	166	NA
MW-15	10/13/1998	5.5-6.5	2.36	<0.05
		10.5-11.5	12.1	<0.104
MW-16	10/13/1998	5.5-6.5	0.821	<0.05
		10.5-11.5	25.4	<0.05
MW-17	10/14/1998	5.5-6.5	38.4	<0.05
		10.5-11.5	4.77	<0.05
MW-18	10/14/1998	5.5-6.5	46.8	NA
		13-13.5	4.33	NA
MW-19	10/14/1998	5.5-6.5	1290	NA
		13-13.5	2240	NA
MW-20	10/14/1998	5.5-6.5	13.5	NA
		13-13.5	2.6	NA
MW-21	10/14/1998	5.5-6.5	60.2	NA
		13-13.5	118	NA

Notes:
Results in micrograms per kilogram.
Samples analyzed by EPA Method 6010.
ND = not detected above reporting limit.
NA = Nota analyzed
<x.x = less than reporting limit.
ft bgs = feet below ground surface.

Table 2-2
Groundwater Analytical Results for Arsenic: 1998-2003
Reichhold/Glacier Site
Seattle, Washington

Location	Dissolved Arsenic Concentration (µg/L)									
	11/2/1998	3/30/1999	4/7/1999	4/21/1999	8/12/1999	3/16/2000	7/6/2000	2/14/2001	6/12/2003	7/29/2003
MW-2S	40.7	–	–	–	2.94	69.3	160	–	–	190
MW3-S	60.6	1030	–	2670	22.7	2,090	1,770	–	–	190
MW3-D		114		36.1						
MW-4S	–	–	–	–	–	–	–	–	–	11.0
MW-6S	–	–	–	–	–	–	–	–	–	14.0
MW-10	9	–	–	–	7.03	28.9	282	–	–	4.0
MW-11	19.1	–	–	–	5.46	1,250	224	–	–	190
MW-12	101	248	–	315	4.83	273	167	–	–	13.0
MW-13	776	66.4	–	312	255	217	1000	–	[illegible]	72.0
MW-14	141	7350	–	1950	14.9	1,950	92	506	–	87.0
MW-17	15.5	124	–	194	24.7	159	–	–	61	48.0
MW-18	25.8	–	270	198	4.88	505	176	31.8	37	28.0
MW-19	29.2	497	–	430	1,100	2,320	2590	724	560	74.0
MW-20	4.17	2340	–	980	–	1,830	403	487	330	73.0
MW-21	84.7	2700	–	1880	3.32	2,210	84.1	58.1	460	190
MW-22	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	9.0
MW-23	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	7.0
MW-24	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ND (<4.0)
MW-25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1,100
MW-26	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	37.0
MW-27	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	10.0

Location	Total Arsenic Concentration (µg/L)									
	11/2/1998	3/30/1999	4/7/1999	4/21/1999	8/12/1999	3/16/2000	7/6/2000	2/14/2001	6/12/2003	7/29/2003
MW-2S	–	–	–	–	79.4	67.6	310	–	–	–
MW3-S	–	–	–	2,750	1,480	3,280	2,350	–	–	–
MW3-D				33.3						
MW-4S	–	–	–	–	–	–	–	–	–	–
MW-6S	–	–	–	–	–	–	–	–	–	–
MW-10	–	–	–	–	69.2	38.2	294	–	–	–
MW-11	–	–	–	–	84.5	1,480	383	–	–	–
MW-12	–	–	–	212	341	160	425	–	–	–
MW-13	–	–	–	380	900	184	5940	–	–	–
MW-14	–	–	–	2,430	396	2,140	1,160	–	–	–
MW-17	–	–	–	198	284	105	–	–	–	–
MW-18	–	–	–	260	89.2	516	177	–	–	–
MW-19	–	–	–	393	3,170	1,970	2,050	–	–	–
MW-20	–	–	–	1,200	–	1,980	375	–	–	–
MW-21	–	–	–	1800	910	2,749	185	–	–	–

Notes:

n/a = well not available (not yet installed during sampling event)

– = not sampled or analyzed for constituent

MW-22 through MW-27 were not installed until July 2003.

Table 2-3
Pre-Treatment Pentachlorophenol (PCP) Concentrations in Groundwater
Reichhold/Glacier Northwest Site
Seattle, Washington

SAMPLE LOCATION	**PRE-Remediation PCP Concentrations (ug/L)**			
	11/2/98	4/21/99	8/12/99	3/16/00
MW-1S	<0.5	--	<0.5	1.01
MW-2S	<0.5	--	<0.5	0.989
MW-4S	0.58	--	0.577	1.4
MW-5S	<0.5	--	<0.5	0.969
MW-6S	<0.5	--	<0.5	1.07
MW-7S	0.546	--	1.55	**304**
MW-10	**63.2**	--	1.13	**15.7**
MW-11	**11.2**	--	<0.5	**18.6**
MW-12	0.925	<0.5	<0.5	1.01
MW-13	**8,040**	**5,320**	**5,340**	**3,410**
MW-14	--	--	--	--
MW-15	<0.5	[illegible]	[illegible]	[illegible]
MW-16	0.933	--	<0.5	--
MW-17	<0.5	<0.5	<0.5	1.34

Notes:
Results in micrograms/liter (ug/L)
ND = Not detected above laboratory reporting limit
J = Estimate value
-- = Not sampled
Bold indicates sample result exceeds the Ecology MTCA Method C cleanup level of 7.29 ug/L

Table 3-1
Pre- and Post-Treatment Pentachlorophenol (PCP) Concentrations in Groundwater
Reichhold/Glacier Northwest Site
Seattle, Washington

SAMPLE	PRE-Remediation PCP Concentrations				Post-Remediation PCP Concentrations (all in ug/L)						
LOCATION	11/2/98	4/21/99	8/12/99	3/16/00	7/6/00	3/21/01	5/31/02	8/13/02	5/12/03	9/15/03	1/15/04
MW-1S	<0.5	--	<0.5	1.01	<0.5	--	--	--	--	--	--
MW-2S	<0.5	--	<0.5	0.989	<0.5	--	--	<5	--	0.79	<.5
MW-4S	0.58	--	0.577	1.4	<0.5	--	--	--	--	--	--
MW-5S	<0.5	--	<0.5	0.969	<0.5	--	--	--	<10	--	--
MW-6S	<0.5	--	<0.5	1.07	<0.5	--	--	--	<10	<0.5	<.5
MW-7S	0.546	--	1.55	**304**	**95**	--	--	--	--	0.18 J	**27**
MW-10	**63.2**	--	1.13	**15.7**	4.44	4.31	--	--	<10	<0.5	11
MW-11	**11.2**	--	<0.5	**18.6**	3.94	1.52	--	--	<10	<0.5	10
MW-12	0.925	<0.5	<0.5	1.01	<0.5	1.44	--	--	<10	<0.5	<.5
MW-13	**8,040**	**5,320**	**5,340**	**3,410**	**849**	**131**	**12**	**10**	<10	**38**	**11**
MW-14	--	--	--	--	--	--	--	--	--	<0.5	<.5
MW-15	<0.5	--	--	--	--	--	--	--	--	--	--
MW-16	0.933	--	<0.5	--	0.833	--	--	--	--	--	--
MW-17	<0.5	<0.5	<0.5	1.34	--	--	--	--	<10	--	--

SAMPLE LOCATION	1/28/04	2/11/04	6/9/04	11/16/04	3/18/05	6/14/05	10/12/05	1/17/06	4/19/06	5/17/06	7/26/06	8/25/06	6/21/07
MW-1S	--	--	--	--	--	--	<.481	--	--	--	--	--	--
MW-2S	--	--	--	--	--	--	1.15	<.472	<.476	--	<.990	--	1.59
MW-4S	--	--	--	--	--	--	<.481	--	--	--	--	--	--
MW-5S	--	--	--	--	--	--	1.14	--	--	--	--	--	--
MW-6S	--	--	--	--	--	--	<.481	<.472	<.490	--	<.990	--	1.16
MW-7S	--	**12**	--	--	--	--	<.481	5.78	**73.4**	**90**	<.962	--	1.18
MW-10	--	<.5	--	--	--	--	<.481	3.15	<.476	--	<1.00	--	1.13
MW-11	<0.5	<.5	--	--	--	--	1.58	<.472	<.490	--	<.990	--	1.31
MW-12	--	--	--	--	--	--	<.476	<.472	<.481	--	<.990	--	1.14
MW-13	**14**	2.2	**25**	**54**	**43**	<.5	3.71	0.606	5.12	--	**267**	**295**	**569**
MW-14	--	--	--	--	--	--	<.481	<.472	<.476	--	<.962	--	<.49
MW-15	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-16	--	--	--	--	--	--	1.58	--	--	--	--	--	--
MW-17	--	--	--	--	--	--	<.481	--	--	--	--	--	--

Notes:

Results in micrograms/liter (ug/L)

ND = Not detected above laboratory reporting limit

J = Estimate value

-- = Not sampled

Bold indicates sample result exceeds the Ecology MTCA Method C cleanup concentration of 7.29 micrograms per liter

TABLE 3-2
Pentachlorophenol (PCP) and By-Product Concentrations in Groundwater Reichhold/Glacier Northwest Site Seattle, Washington

SAMPLE	Sample	Sample Location	
Paramater	Date	MW-11	MW-13
PCP	9/15/2003	ND	38 D
2-chlorophenol	9/15/2003	ND	0.17 J
2,4-dichlorophenol	9/15/2003	ND	1.1
2,4,6-trichlorophenol	9/15/2003	ND	0.78
2,4,5-trichlorophenol	9/15/2003	ND	0.37 J

Notes:

Results in micrograms/liter (ug/L)

ND = Not detected above laboratory reporting limit

J = Estimate value

-- = Not sampled

Table 4-1
Groundwater Elevation Data from September 2003
Reichhold/Glacier Site
Seattle, Washington

Well ID	Date	TOC (ft)	DTW (ft)	DTB (ft)	GWE (ft)
MW-1S	09/08/03	17.68	9.25	12.75	8.43
MW-1D	09/08/03	17.16	16.66	26.20	0.50
MW-2S	09/08/03	17.41	8.60	12.50	8.81
MW-2D	09/08/03	17.43	17.22	25.60	0.21
MW-3S	09/08/03	19.46	12.50	13.85	6.96
MW-3D	09/08/03	19.45	16.48	28.40	2.97
MW-4S	09/08/03	18.82	10.20	12.92	8.62
MW-5S	09/08/03	18.41	10.02	13.15	8.39
MW-6S	09/08/03	18.48	9.98	12.95	8.50
MW-7S	09/08/03	18.48	9.95	13.05	8.53
MW-10	09/08/03	14.86	6.81	10.05	8.05
MW-11	09/08/03	15.35	7.31	10.35	8.04
MW-12	09/08/03	15.86	7.65	11.65	8.21
MW-13	09/08/03	14.94	7.98	11.73	6.96
MW-14	09/08/03	16.36	8.38	10.90	7.98
MW-16	09/08/03	13.77	5.15	10.05	8.62
MW-17	09/08/03	15.99	7.45	11.25	8.54
MW-18	09/08/03	17.21	10.07	12.95	7.14
MW-19	09/08/03	16.85	8.98	12.75	7.87
MW-20	09/08/03	17.41	10.05	10.20	7.36
MW-21	09/08/03	16.81	8.60	12.80	8.21
MW-22	09/08/03	16.73	8.71	15.60	8.02
MW-23	09/08/03	16.30	7.96	15.70	8.34
MW-24	09/08/03	16.28	9.85	15.75	6.43
MW-25	09/08/03	17.21	9.81	15.40	7.40
MW-26	09/08/03	16.60	9.84	15.50	6.76
MW-27	09/08/03	16.66	12.40	15.80	4.26

Notes:

TOC = top of casing elevation
DTW = depth to water
DTB = depth to bottom
GWE = groundwater elevation
ft = feet
Elevations are based on a survey by Aliant Engineering and Land Surveying, Inc. and are relative to Seattle Benchmark 5327.

Table 4-2
Soil Analytical Results for Arsenic: 2003
Reichhold/Glacier Northwest Site
Seattle, Washington

Well ID	Sample Date	Sample Depth (ft bgs)	Arsenic (mg/kg)
MW-22	07/22/03	5-5.5	160
		8-8.5	5.7
		13-13.5	7.9
MW-23	07/22/03	5-5.5	7.2
		8.5-9	ND (<4.2)
		13-13.5	ND (<6.2)
MW-24	07/23/03	3-3.5	ND (<4.2)
		8.5-9	ND (<4.0)
		13-13.5	ND (<5.9)
MW-25	07/23/03	3.5-4	ND (<2.7)
		8-8.5	11
		13-13.5	ND (<7.8)
MW-26	07/23/03	5.5-6	180
		8-8.5	9.1
		10.5-11	250
		13-13.5	24
MW-27	07/23/03	5.5-6	ND (<3.6)
		8-8.5	ND (<3.7)
		10.5-11	ND (<4.4)
		13-13.5	ND (<3.6)

Notes:

Results in milograms per kilogram.

Samples analyzed by EPA Method 6010.

ND = not detected above reporting limit.

NA = not analyzed

<x.x = less than reporting limit.

ft bgs = feet below ground surface.

Table 5-1
Dissolved Arsenic Groundwater Analytical Results: Pre- vs. Post-Remediation
Reichhold/Glacier Site
Seattle, Washington

Wells in Treatment zone	Pre-Trreatment Dissolved Concentrations						Average Concentration	Treatment	Post-Treatment			% Reduction
	11/2/1998	3/30/1999	4/7/1999	4/21/1999	8/12/1999	3/16/2000		7/6/2000	2/14/2001	6/12/2003	7/29/2003	[Ave/(Jul03)]
MW3-S	60.6	1,030	--	2,670	22.7	2,090	**1,175**	1,770	--	--	**190**	**84%**
MW-14	141	7350	--	1,950	14.9	1,950	**2,281**	92	506	--	**87.0**	**96%**
MW-18	25.8	--	270	198	4.88	505	**201**	176	31.8	37	**28.0**	**86%**
MW-19	29.2	497	--	430	1,100	2,320	**875**	2,590	724	560	**74.0**	**92%**
MW-20	4.17	2,340	--	980	--	1,830	**1,289**	403	487	330	**73.0**	**94%**
MW-21	84.7	2,700	--	1,880	3.32	2,210	**1,376**	84.1	58.1	460	**190**	**86%**
MW-22	n/a	n/a	n/a	n/a	n/a	n/a	--	n/a	n/a	n/a	**9.0**	--
MW-23	n/a	n/a	n/a	n/a	n/a	n/a	--	n/a	n/a	n/a	**7.0**	--
MW-24	n/a	n/a	n/a	n/a	n/a	n/a	--	n/a	n/a	n/a	**ND (<4.0)**	--

Notes:

Dissolved concentrations reported in micrograms/liter (ug/L)

only those wells within the arsenic treatment zone are listed

Percent reduction equals the latest concentration (July 29, 2003) divided by average concentration from pre-treatment sampling events

n/a = well not available (not installed)

-- = not sampled or analyzed for constituent

Table 5-2
Dissolved and Total Arsenic Ratios in Groundwater
Reichhold/Glacier Site
Seattle, Washington

Location	Total and Dissolved Arsenic Concentrations (ug/L)											
	4/21/1999			8/12/1999			3/16/2000			7/6/2000		
	Total	Dissolved	ratio	Total	Dissolved	ratio	Total	Dissolved	ratio	Total	Dissolved	ratio
MW-2S	--	--		79.4	2.94	0.04	67.6	69.3	1.03	310	160	0.52
MW-3S	2,750	2,670	0.97	1,480	22.7	0.02	3,280	2,090	0.64	2,350	1,770	0.75
MW-10	--	--		69.2	7.03	0.10	38.2	28.9	0.76	294	282	0.96
MW-11	--	--		84.5	5.46	0.06	1,480	1,250	0.84	383	224	0.58
MW-12	212	315	1.49	341	4.83	0.01	160	273	1.71	425	167	0.39
MW-13	380	312	0.82	900	255	0.28	184	217	1.18	5,940	1,000	0.17
MW-14	2,430	1,950	0.80	396	14.9	0.04	2,140	1,950	0.91	1,160	92	0.08
MW-17	198	194	0.98	284	24.7	0.09	105	159	1.51	--	--	
MW-18	260	198	0.76	89.2	4.88	0.05	516	505	0.98	177	176	0.99
MW-19	393	430	1.09	3,170	1,100	0.35	1,970	2,320	1.18	3,050	2,590	0.85
MW-20	1,200	980	0.82	--	--		1,980	1,830	0.92	375	403	1.07
MW-21	1,800	1,880	1.04	910	3.32	0.004	2,740	2,210	0.807	185	84.1	0.45

Notes:

only those wells with total and dissolved results are shown in the table

Ratio = dissolved / total

n/a = well not available (not installed)

-- = not sampled or analyzed for constituent

Table 5-3
Dissolved and Total Iron Ratios in Groundwater
Reichhold/Glacier Site
Seattle, Washington

Location	Total and Dissolved Iron Concentrations (ug/L)								
	8/12/1999			3/16/2000			7/6/2000		
	Total	Dissolved	ratio	Total	Dissolved	ratio	Total	Dissolved	ratio
MW-2S	15,900	158	0.01	11,300	n/a		17,800	7,330	0.41
MW-3S	25,300	168	0.01	39,300	n/a		28,500	27,100	0.95
MW-4S	--	--		--	n/a		--	--	
MW-6S	--	--		--	n/a		--	--	
MW-10	41,800	189	0.005	5,920	n/a		17300	3120	0.18
MW-11	17,200	***150***	0.009	10,500	n/a		25,200	5,860	0.23
MW-12	13,400	***150***	0.011	11,200	n/a		18,200	3570	0.20
MW-13	21,200	430	0.02	8,400	n/a		221,000	767	0.00
MW-14	9,510	175	0.02	22,000	n/a		14,200	274	0.02
MW-17	19,400	164	0.01	1,800	n/a		--	--	
MW-18	26,600	4,440	0.17	34300	n/a		20,200	17,900	0.89
MW-19	25,800	186	0.01	15,000	n/a		19,700	12,100	0.61
MW-20	--	--		27,900	n/a		34,000	35,500	1.04
MW-21	44,100	***150***	0.003	24,400	n/a		14,300	1,110	0.08

Notes:

only those wells with total and dissolved results are shown in the table

Ratio = dissolved / total

bold, italic concentrations are reporting limits for non-detect results

n/a = well not available (not installed)

-- = not sampled or analyzed for constituent

Figures

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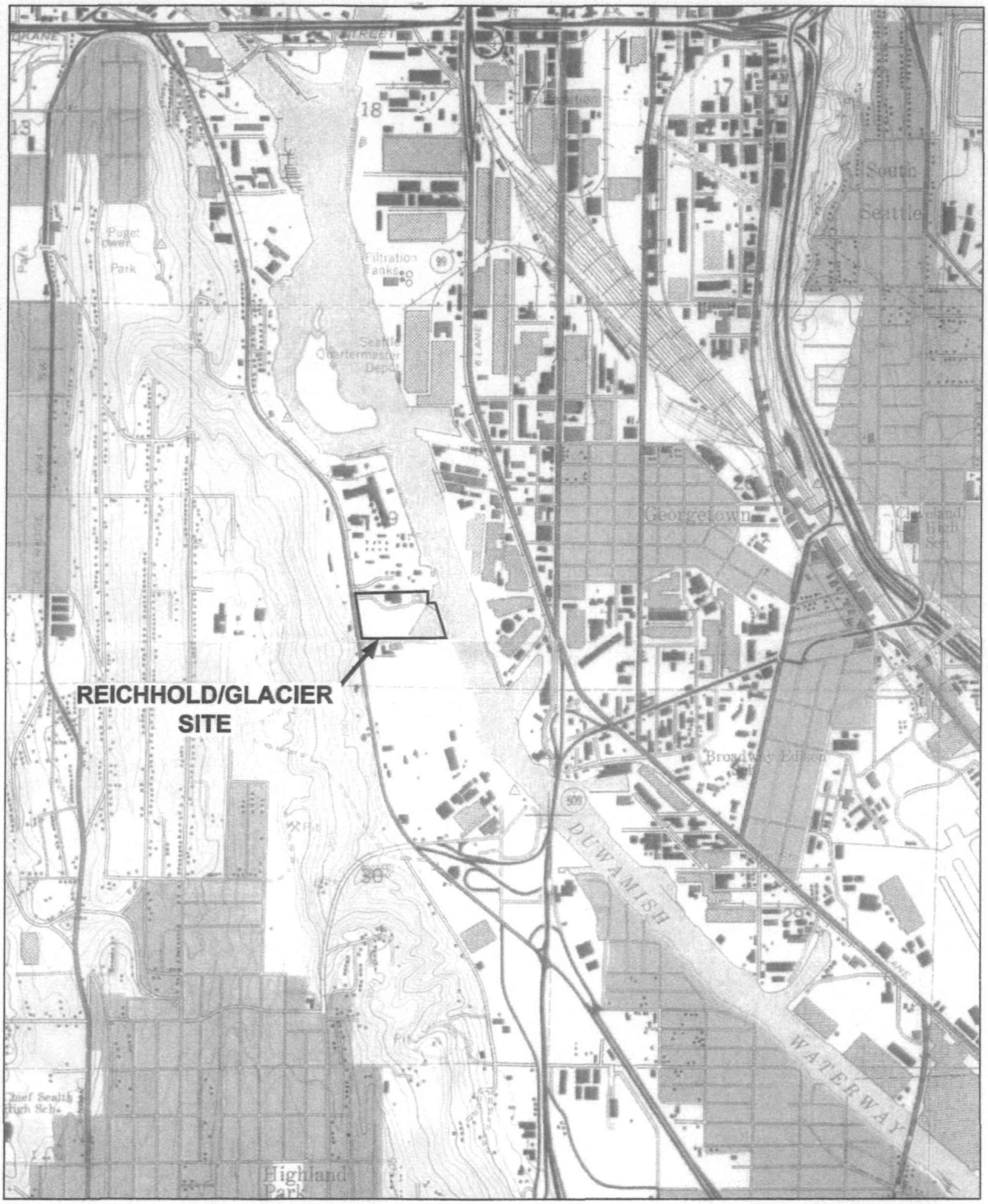


SCALE

0 2000 4000 FEET

SOURCE: USGS 7.5' QUAD SHEET
SEATTLE SOUTH, WASHINGTON, PHOTO REVISED 1973

19909 120th Avenue N.E., Suite 101
Bothell, Washington 98011
Phone (425) 485-5000
Fax. (425) 486-9766

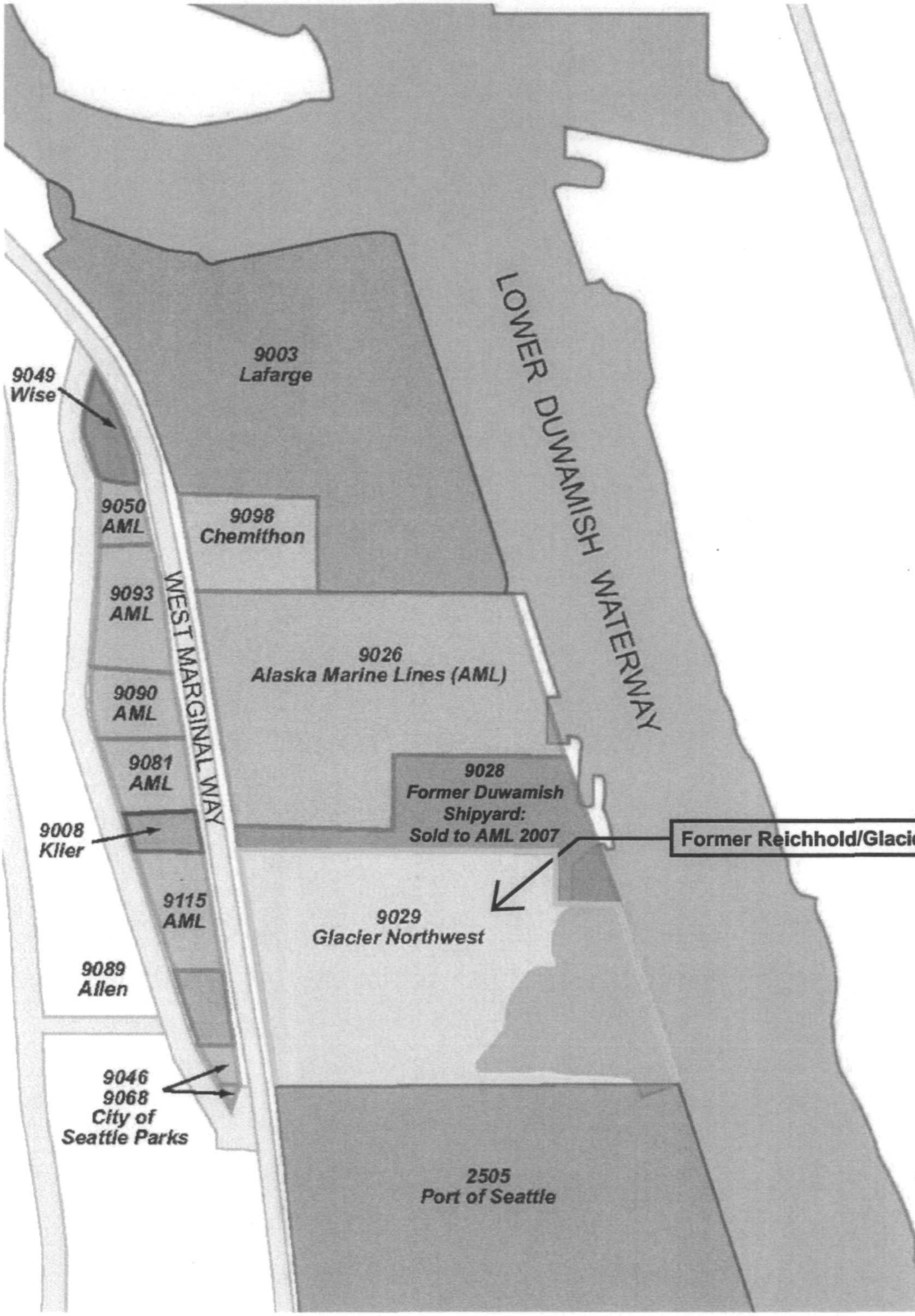
Shaw® Shaw Environmental, Inc.

FIGURE 1-1

SITE LOCATION MAP

REICHHOLD/GLACIER
5900 W. MARGINAL WAY S.W.
SEATTLE, WASHINGTON

N:\Project\draft\Reichhold\2008\PASR_April\Drawings 2008\BT-20600335-F1-1.dwg User: maria.portacio Plotted: Apr 29, 2008 - 10:03am Last Save: Apr 29, 2008 - 9:38am



SOURCE: LOWER DUWAMISH WATERWAY GLACIER BAY SOURCE CONTROL AREA REPORT, SAIC, JUNE 2007

NOT TO SCALE

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FIGURE 2-1
SITE AND SURROUNDING PROPERTIES
REICHHOLD/GLACIER
5900 W. MARGINAL WAY S.W.
SEATTLE, WASHINGTON

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XREF Files: IMAGE Files: site map.jpg
File: N:\Project\draft\Reichhold\2008\RASR_April\Drawings 2008\BT-20600335-F2-1.dwg Layout: figure 1 User: maria.portacio Apr 30, 2008 - 11:48am

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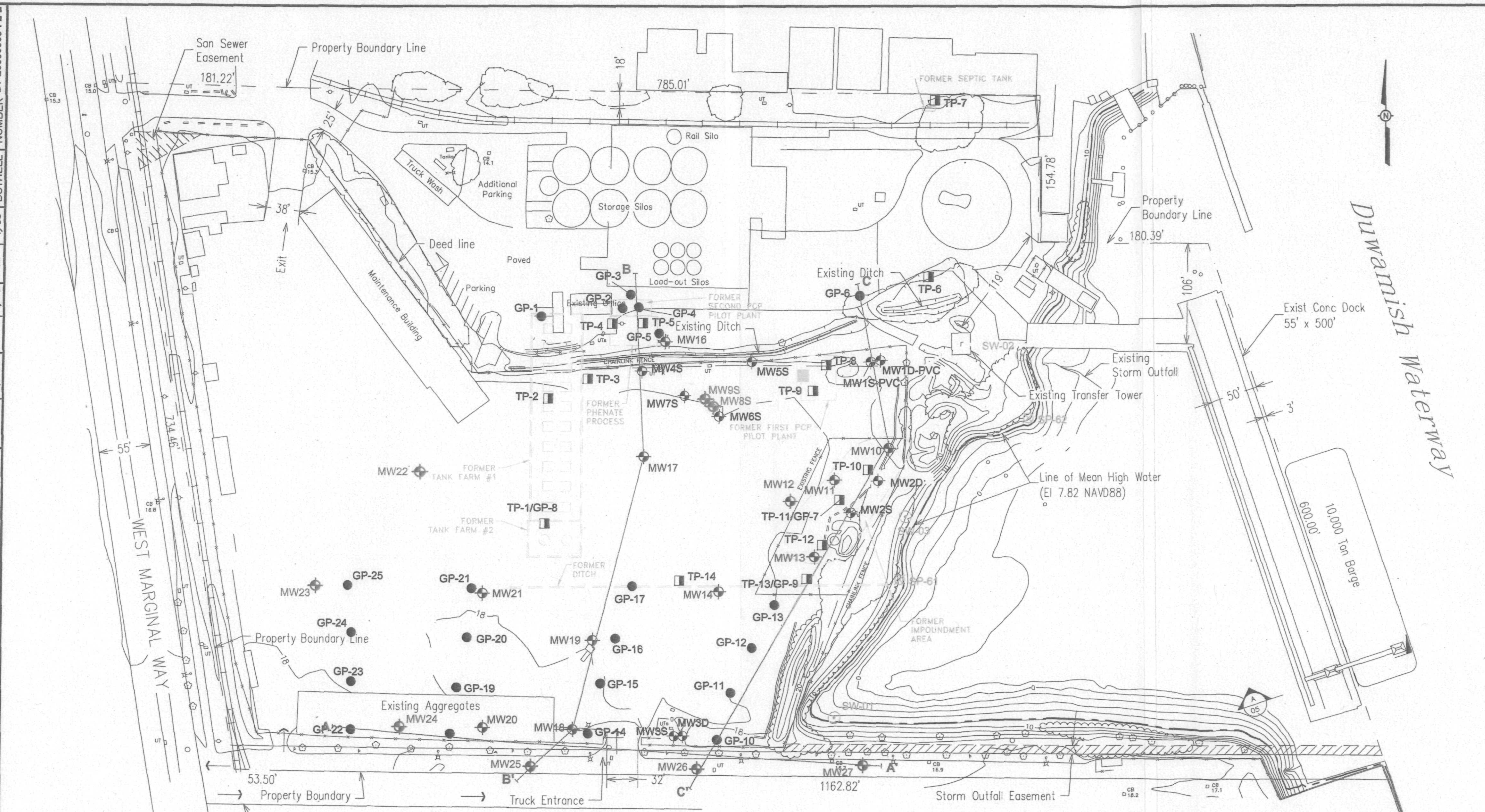

SCALE

0 100 200 FEET

SOURCE: GLACIER NORTHWEST

Topographic information shown is derived from photogrametric mapping performed by Nies Mapping Group, project 99098. Date of photo is 4-13-99. Contour interval is 2 feet.

LEGEND:

- A — A' Cross Section Locations
- Existing Monitoring Well (RETEC, 1995)
- Test Pit Locations (RETEC, 1995)
- Geoprobe Locations (RETEC, 1995)
- Estimated PCP Concentration Groundwater Contour from RI (RETEC, 1995)
- Shaw (2003)
- Fluor Daniel GTI (1998)
- Fluor Daniel GTI (1997)
- Ozone Sparge Remediation Trailer
- Seep Water Sample Location (Hart Crowser, 1995)
- Seep Sample Location (Windward, 2004)

Note: All locations are approximate.

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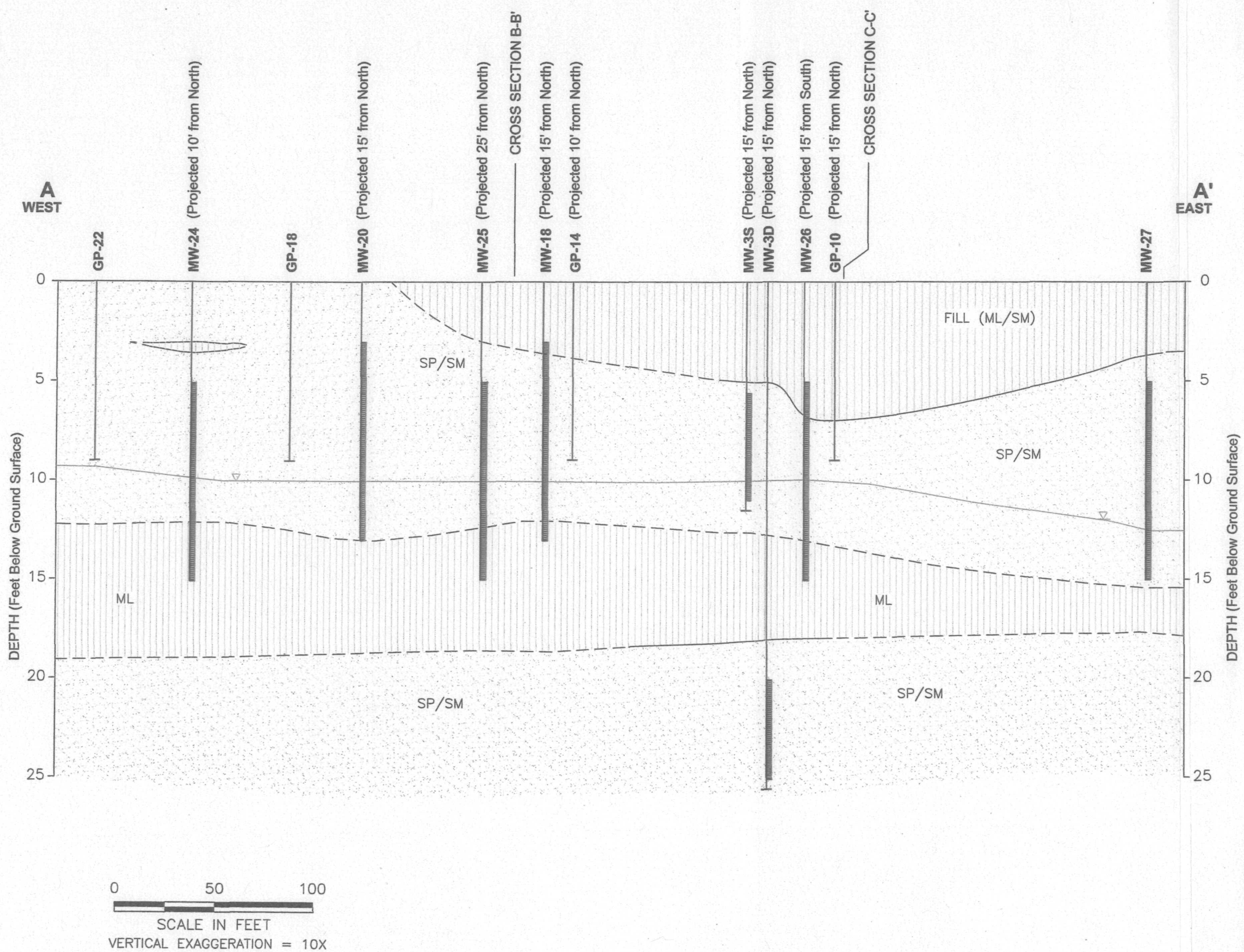
FIGURE 2-2

SITE PLAN

REICHHOLD/GLACIER
5900 W. MARGINAL WAY S.W.
SEATTLE, WASHINGTON



EXPLANATION:

- Screen Interval
- Shallow Water Level (Approx.)
- **ML** Silt, Clayey Silt Some Sand
- **SM/ML** Silty Sand to Sandy Silt (Fill)
- **SP/SM** Poorly Graded Sand to Silty Sand

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FIGURE 2-3

CROSS SECTION A-A'

REICHHOLD/GLACIER
5900 W. MARGINAL WAY S.W.
SEATTLE, WASHINGTON

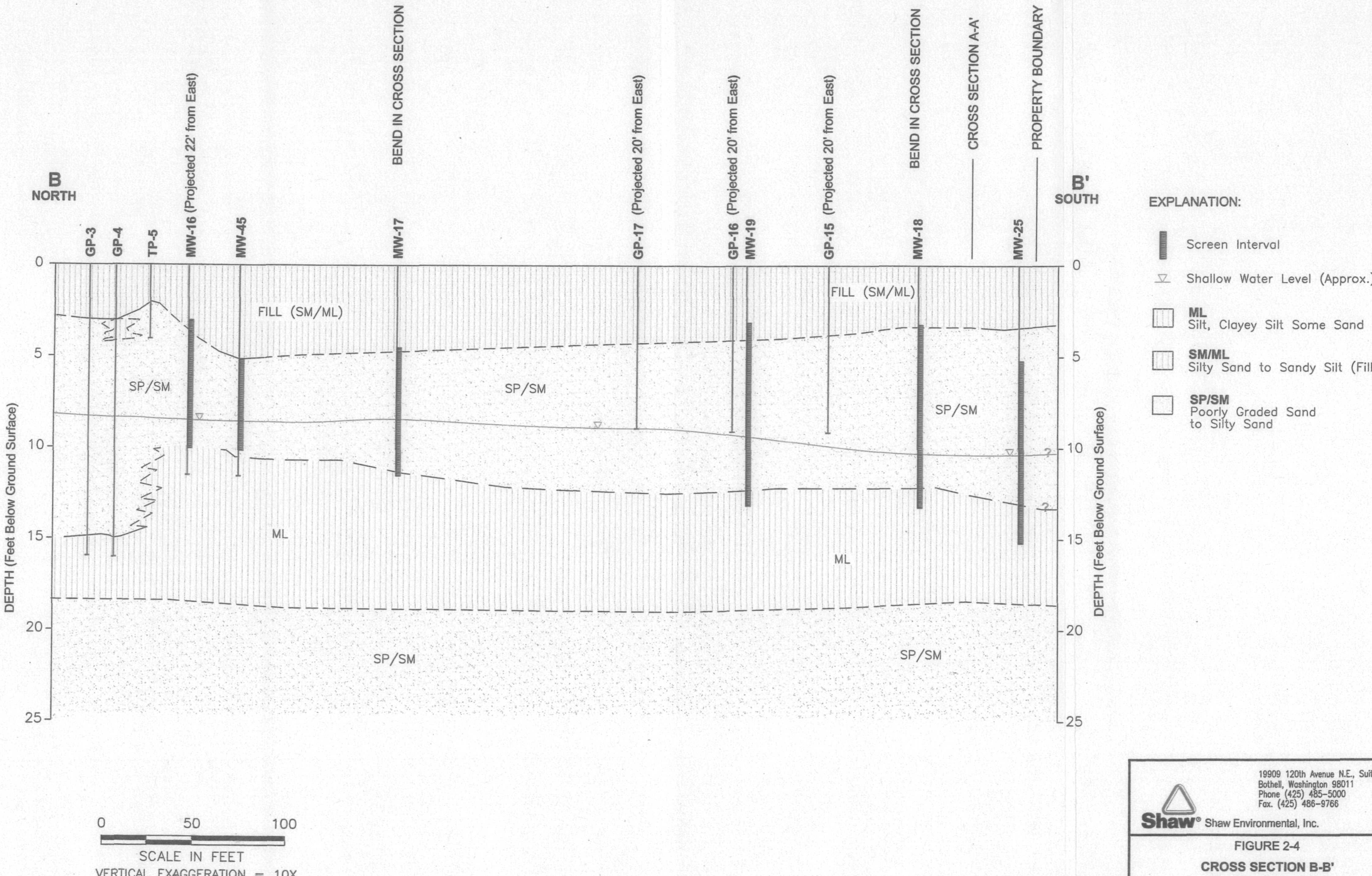

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FIGURE 2-4

CROSS SECTION B-B'

REICHHOLD/GLACIER
5900 W. MARGINAL WAY S.W.
SEATTLE, WASHINGTON

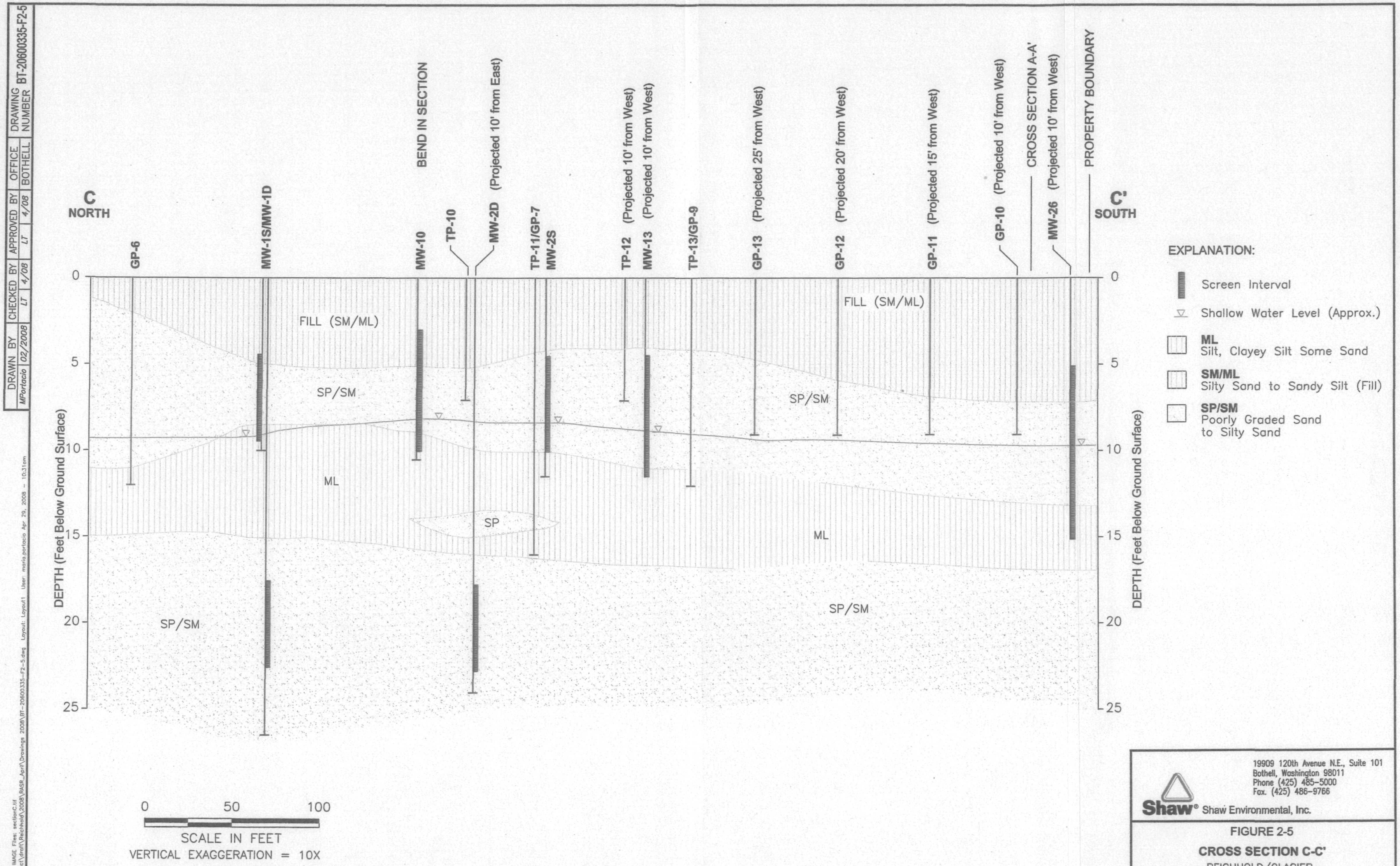

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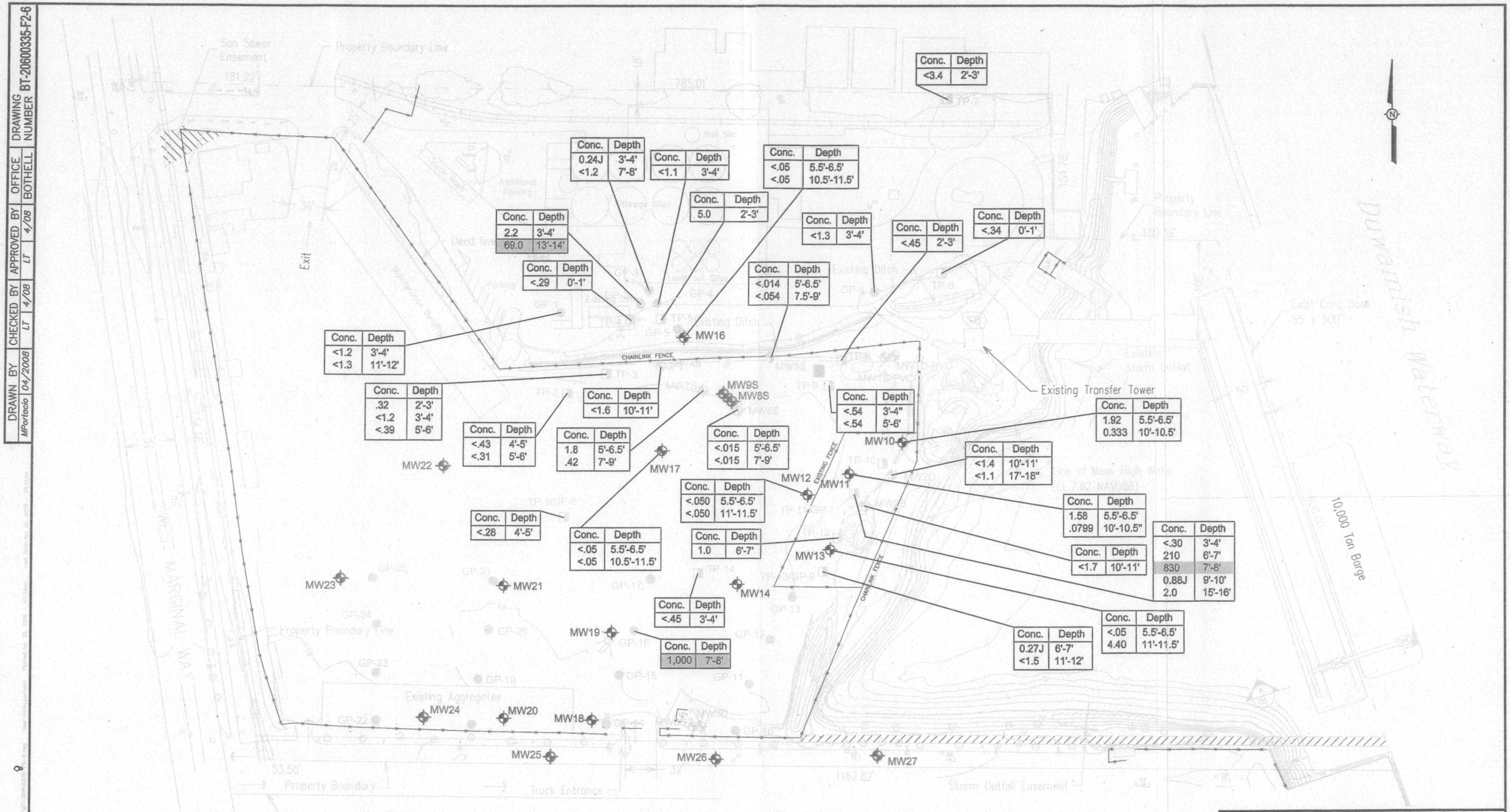
FIGURE 2-5

CROSS SECTION C-C'

REICHHOLD/GLACIER
5900 W. MARGINAL WAY S.W.
SEATTLE, WASHINGTON



SCALE

0 100 200 FEET

SOURCE: GLACIER NORTHWEST

Topographic information shown is derived from photogrametric mapping performed by Nies Mapping Group, project 99098. Date of photo is 4-13-99. Contour interval is 2 feet.

LEGEND:

- Existing Monitoring Well (RETEC, 1995)
- Test Pit Locations (RETEC, 1995)
- Geoprobe Locations (RETEC, 1995)
- Shaw (2003)
- Fluor Daniel GTI (1998)
- Fluor Daniel GTI (1997)
- Ozone Sparge Remediation Trailer

Conc.	Depth
<18	3'-4'

PCP Concentrations in Soil (mg/kg)

Note: All locations are approximate.

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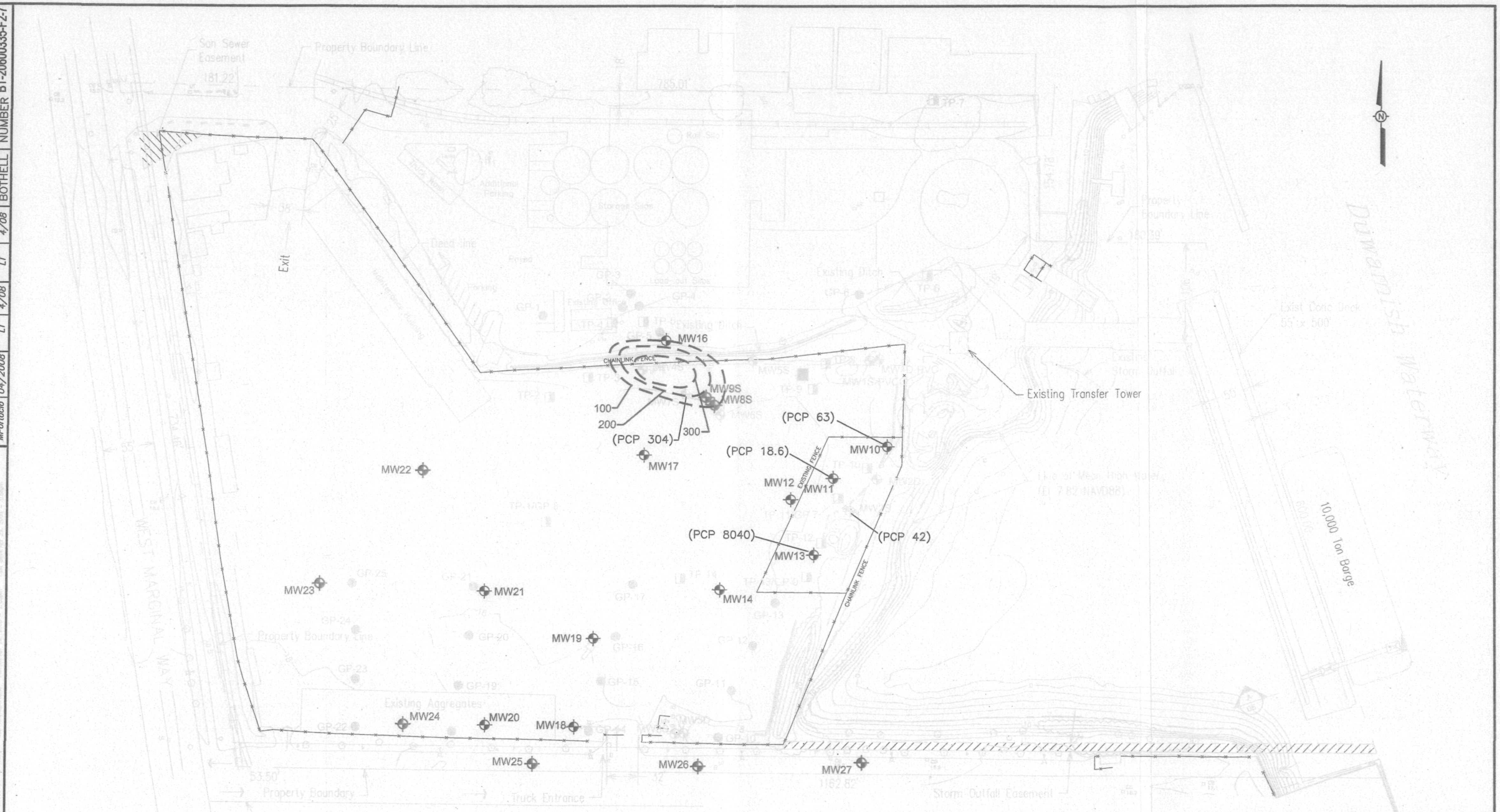
FIGURE 2-6
PENTACHLOROPHENOL CONCENTRATIONS (PCP) IN SOIL
REICHHOLD/GLACIER
5900 W. MARGINAL WAY S.W.
SEATTLE, WASHINGTON



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SCALE

0 100 200 FEET

SOURCE: GLACIER NORTHWEST

Topographic information shown is derived from photogrametric mapping performed by Nies Mapping Group, project 99098. Date of photo is 4-13-99. Contour interval is 2 feet.

LEGEND:

- Existing Monitoring Well (RETEC, 1995)
- Test Pit Locations (RETEC, 1995)
- Geoprobe Locations (RETEC, 1995)

Note: All locations are approximate.

- Estimated PCP Concentration Groundwater Contour from RI (RETEC, 1995)
- Shaw (2003)
- Fluor Daniel GTI (1998)
- Fluor Daniel GTI (1997)
- Ozone Sparge Remediation Trailer
- (PCP 42) Peak Pretreatment Pentachlorophenal Concentration (μg/L) in Groundwater

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FIGURE 2-7
PEAK PRETREATMENT PENTACHLOROPHENOL CONCENTRATIONS IN GROUNDWATER
REICHHOLD/GLACIER
5900 W. MARGINAL WAY S.W.
SEATTLE, WASHINGTON

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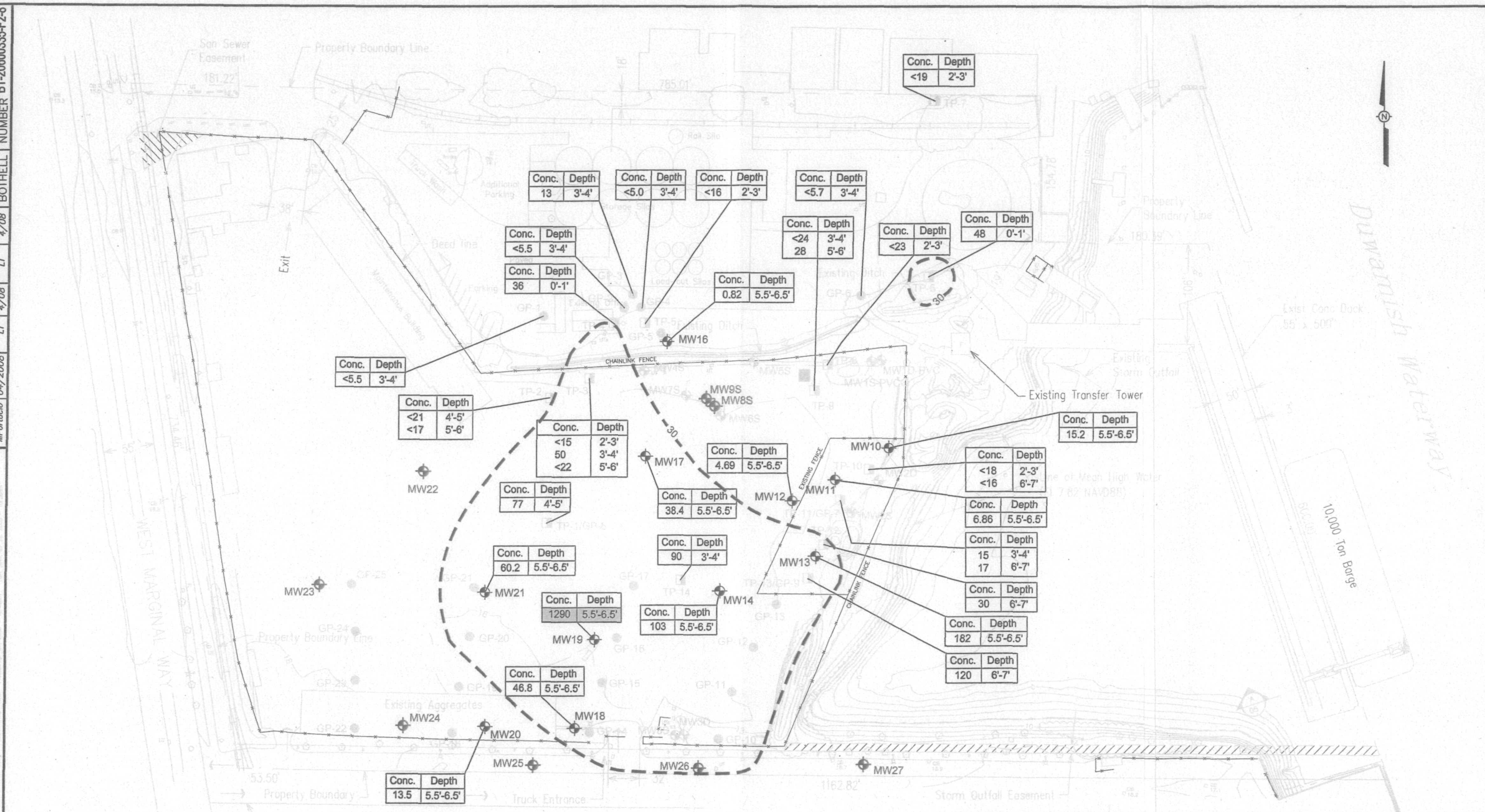

SCALE

0 100 200 FEET

SOURCE: GLACIER NORTHWEST

Topographic information shown is derived from photogrametric mapping performed by Nies Mapping Group, project 99098. Date of photo is 4-13-99. Contour interval is 2 feet.

LEGEND:

- Existing Monitoring Well (RETEC, 1995)
- Test Pit Locations (RETEC, 1995)
- Geoprobe Locations (RETEC, 1995)
- mg/kg = milligrams per kilogram
- Note: All locations are approximate.
- — 30 — Estimated Areal Contour of Total Arsenic Concentrations greater than ~ 30 mg/kg in Soil Samples
- Shaw (2003)
- Fluor Daniel GTI (1998)
- Fluor Daniel GTI (1997)
- Ozone Sparge Remediation Trailer
- Conc. / Depth (<5.5 / 3'-4') Arsenic Concentrations in Soil (mg/kg) From 0'-7' Below Ground Surface

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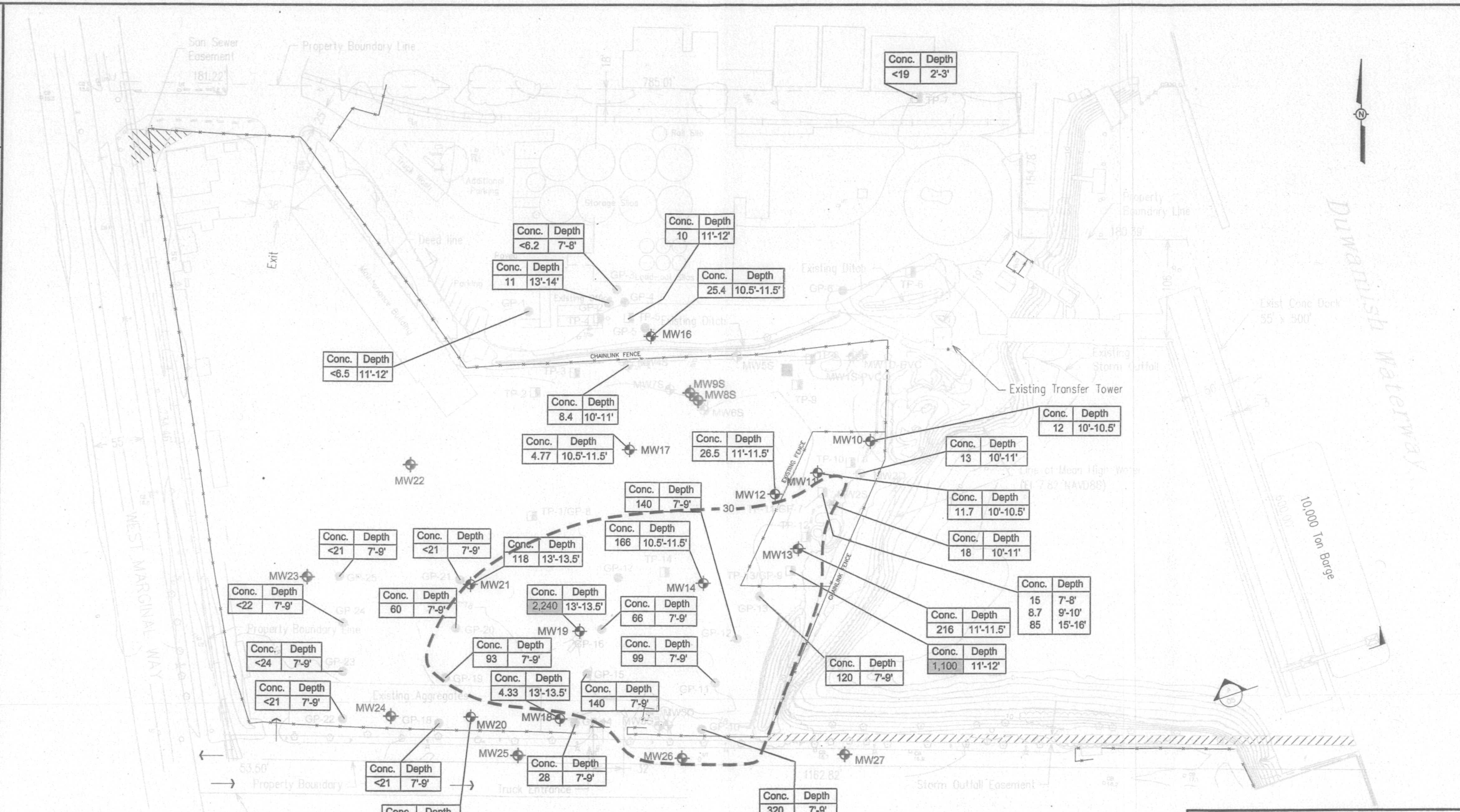
FIGURE 2-8
PRETREATMENT ARSENIC CONCENTRATIONS IN SOIL FROM 0'-7' BELOW GROUND SURFACE
REICHHOLD/GLACIER
5900 W. MARGINAL WAY S.W.
SEATTLE, WASHINGTON



LEGEND:

- Existing Monitoring Well (RETEC, 1995)
- Test Pit Locations (RETEC, 1995)
- Geoprobe Locations (RETEC, 1995)

mg/kg = milligrams per kilogram

Note: All locations are approximate.

- 30 — Estimated Areal Contour of Total Arsenic Concentration in Soil Samples greater than 30 mg/kg
- Shaw (2003)
- Fluor Daniel GTI (1998)
- Fluor Daniel GTI (1997)
- Ozone Sparge Remediation Trailer

Conc.	Depth
26.5	11'-11.5'

Total Arsenic Concentrations in Soil (mg/kg) From 7'-16' Below Ground Surface

SOURCE: GLACIER NORTHWEST

Topographic information shown is derived from photogrammetric mapping performed by Nies Mapping Group, project 99098. Date of photo is 4-13-99. Contour interval is 2 feet.

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FIGURE 2-9

PRETREATMENT ARSENIC CONCENTRATIONS IN SOIL FROM 7'-16' BELOW GROUND SURFACE

REICHHOLD/GLACIER
5900 W. MARGINAL WAY S.W.
SEATTLE, WASHINGTON

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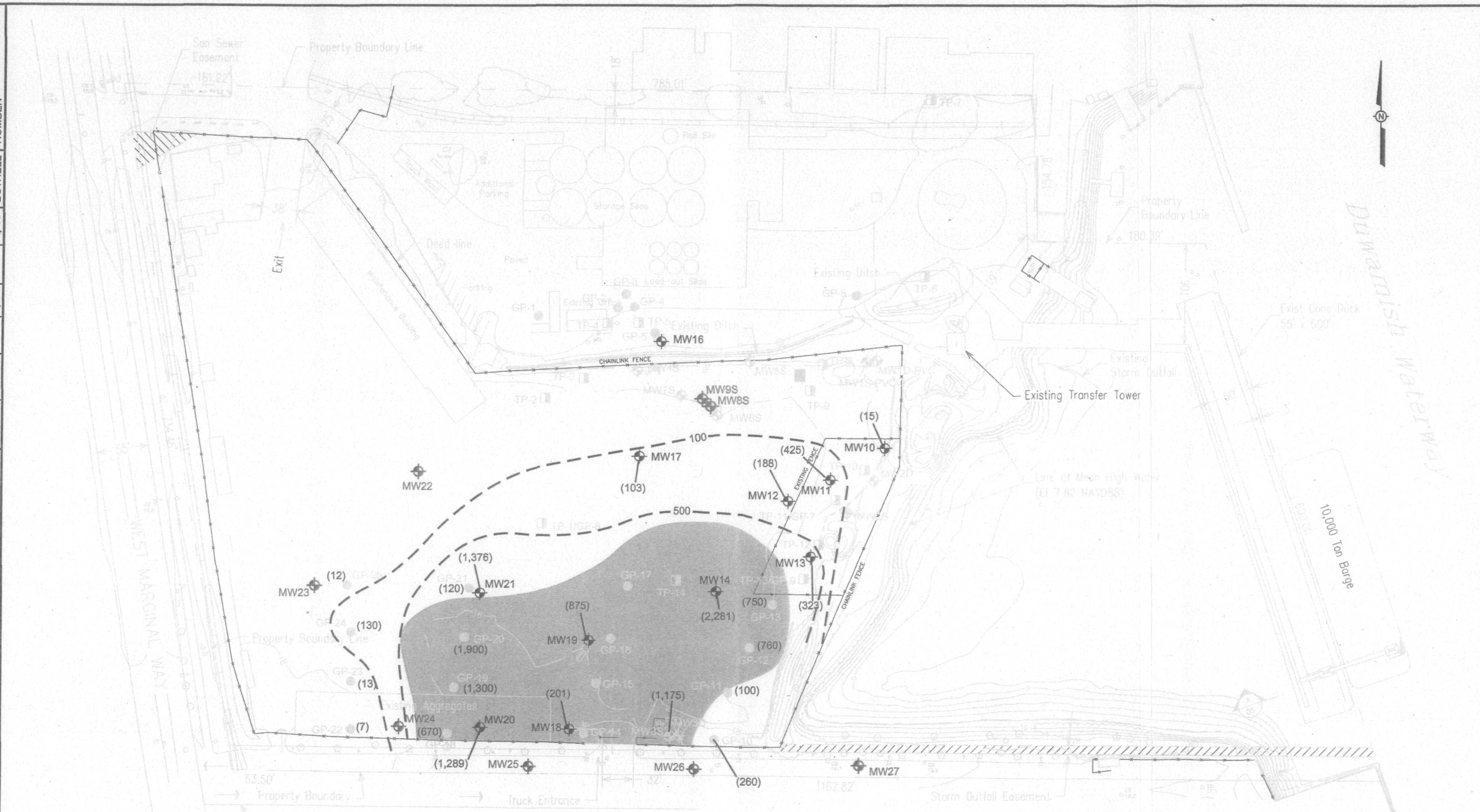

SCALE

0 100 200 FEET

SOURCE: GLACIER NORTHWEST

Topographic information shown is derived from photogrammetric mapping performed by Nies Mapping Group, project 99098. Date of photo is 4-13-99. Contour interval is 2 feet.

LEGEND:

- Existing Monitoring Well (RETEC, 1995)
- Test Pit Locations (RETEC, 1995)
- Geoprobe Locations (RETEC, 1995)
- μg/L = Micrograms per Liter
- Area with Dissolved Arsenic Concentration Greater than 500 μg/L from RI (RETEC, 1995)
- (1,000) Average Dissolved Arsenic Concentration from sampling events (1998–2000) in μg/L
- —100— Estimated Dissolved Arsenic Concentrations Groundwater Contours in μg/L
- Shaw (2003)
- Fluor Daniel GTI (1998)
- Fluor Daniel GTI (1997)
- Ozone Sparge Remediation Trailer

Note: All locations are approximate.

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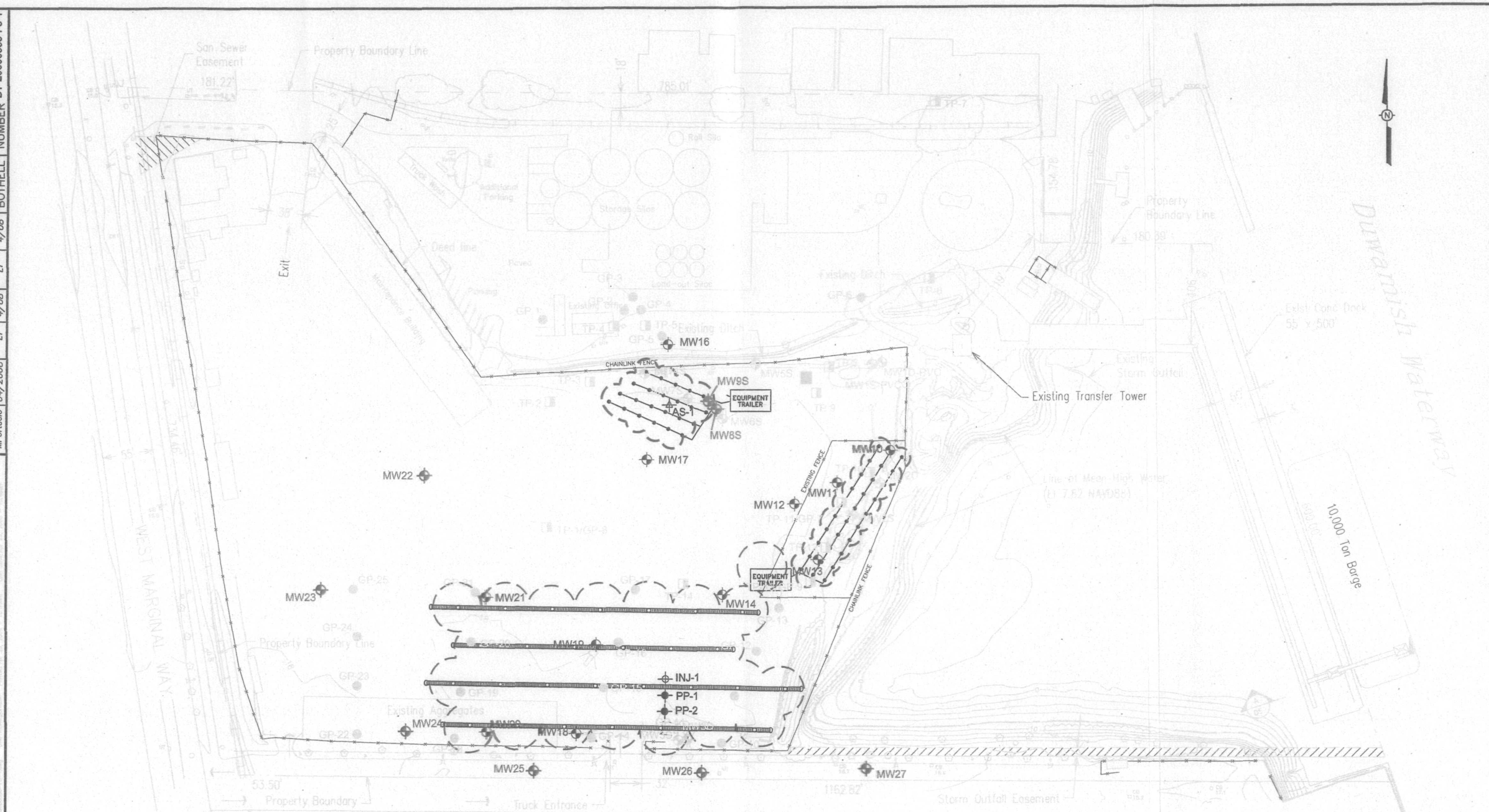
FIGURE 2-10
PRETREATMENT DISSOLVED ARSENIC CONCENTRATIONS IN GROUNDWATER
REICHHOLD/GLACIER
5900 W. MARGINAL WAY S.W.
SEATTLE, WASHINGTON



LEGEND:

- INJ-1 Injection Well
- PP-1 / PP-2 Push–Pull Test Monitoring Well
- Air Sparge Well
- Existing Monitoring Well (RETEC, 1995)
- Test Pit Locations (RETEC, 1995)
- Geoprobe Locations (RETEC, 1995)
- Ozone Treatment Area
- Arsenic Treatment Area
- Shaw (2003)
- Fluor Daniel GTI (1998)
- Fluor Daniel GTI (1997)
- Ozone Sparge Remediation Trailer
- Injection Well Locations

Note: All locations are approximate.

SCALE

0 100 200 FEET

SOURCE: GLACIER NORTHWEST

Topographic information shown is derived from photogrametric mapping performed by Nies Mapping Group, project 99098. Date of photo is 4-13-99. Contour interval is 2 feet.

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FIGURE 3-1
REMEDIATION SYSTEMS SCHEMATIC

REICHHOLD/GLACIER
5900 W. MARGINAL WAY S.W.
SEATTLE, WASHINGTON

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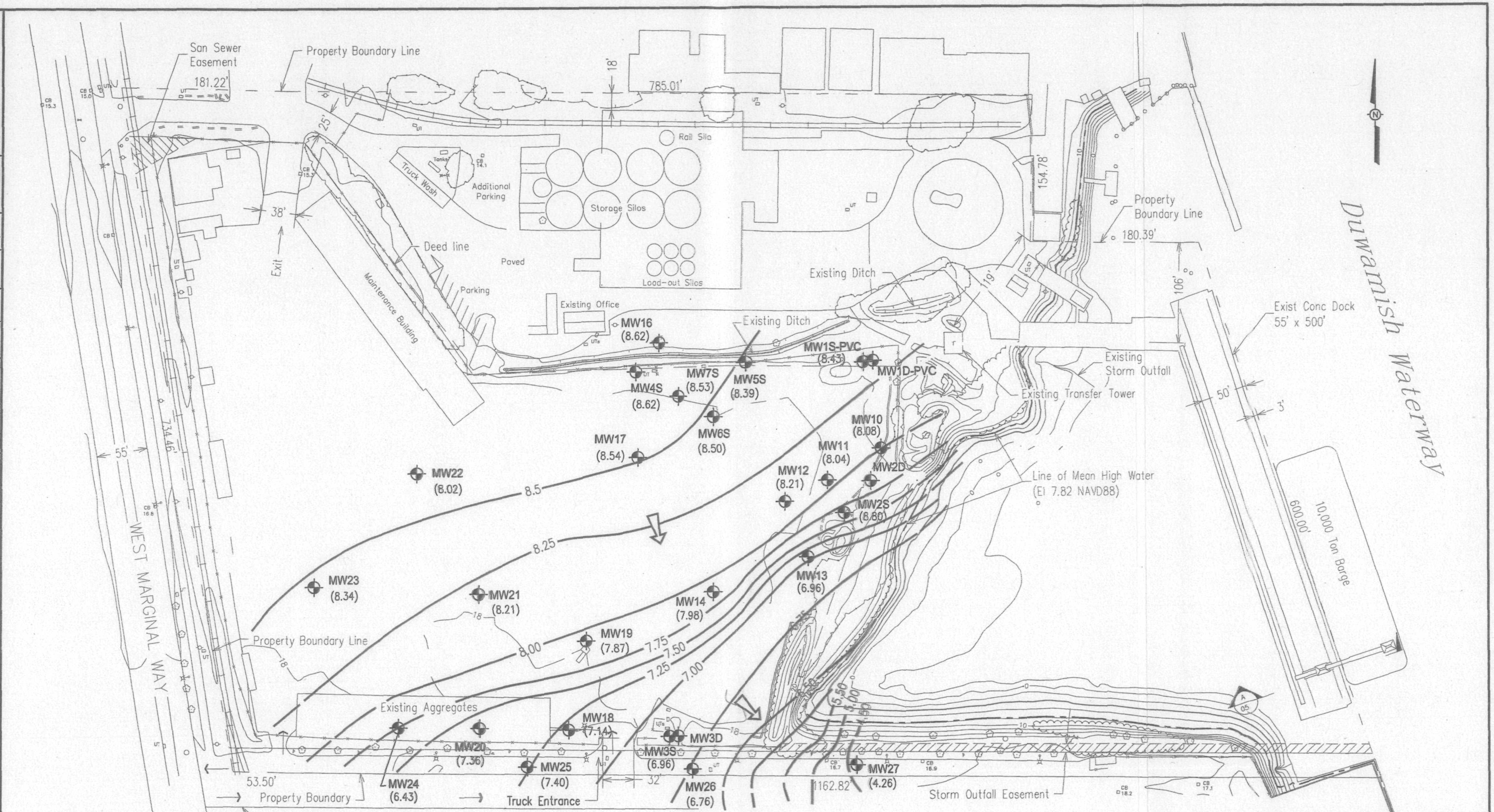

DRAWN BY	CHECKED BY	APPROVED BY	OFFICE	DRAWING NUMBER
MPortacio 04/2008	LT 4/08	LT 4/08	BOTHELL	BT-20600335-F4-1

SCALE

0 100 200 FEET

SOURCE: GLACIER NORTHWEST
Glacier Northwest Contact:
Victor Ghigleri 206-764-3056

NOTE:
Elevation Data From MW-2S, MW-22, MW-24 And Deep Aquifer Wells Not Used In Elevation Contour Mapping

Topographic information shown is derived from photogrametric mapping performed by Nies Mapping Group, project 99098. Date of photo is 4-13-99. Contour interval is between .25 to .50 feet.

LEGEND:

- Existing Monitoring Well
- Approx. Groundwater Flow Direction
- —7.50— Groundwater Elevation Contour (Feet Above Mean Sea Level)

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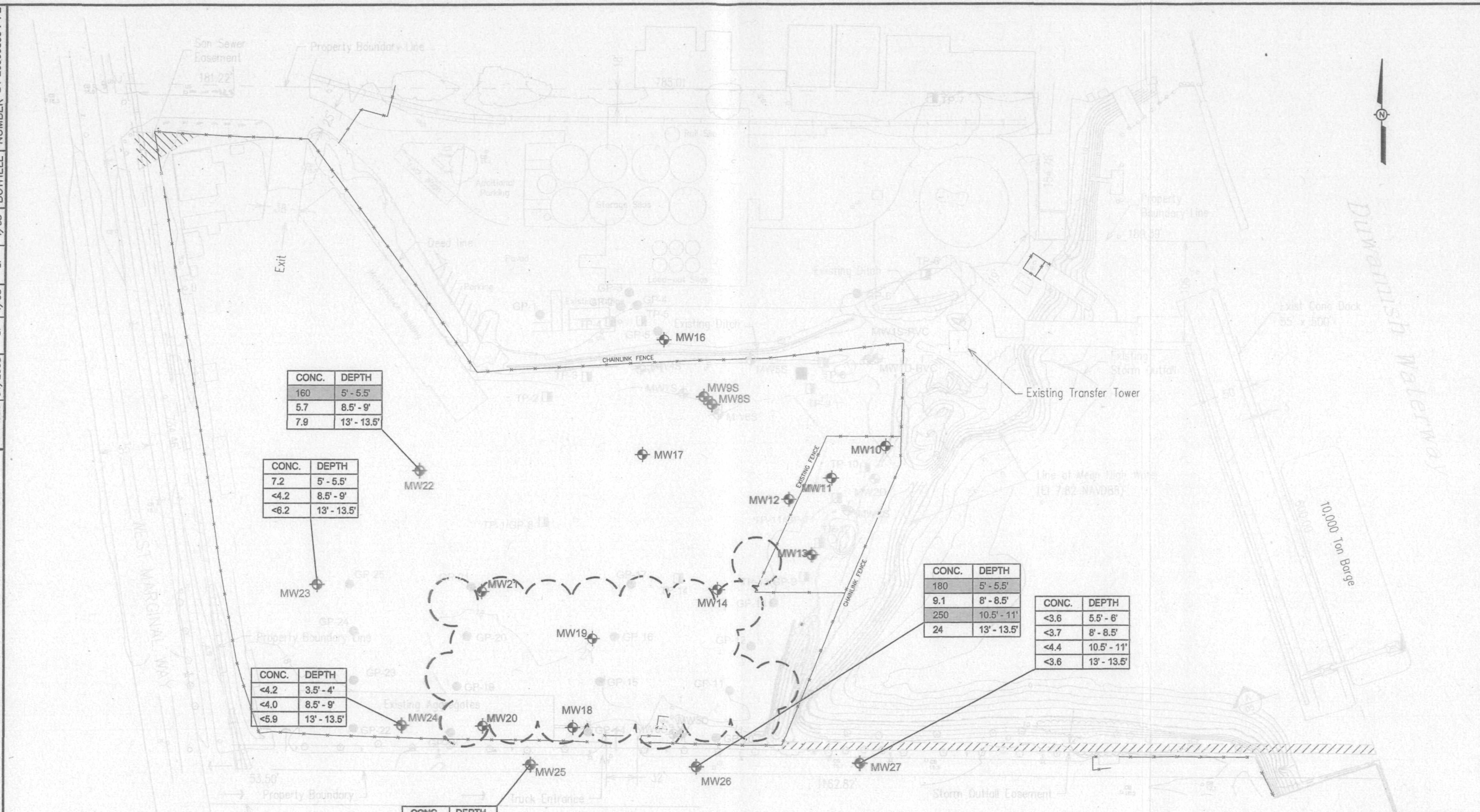
FIGURE 4-1
GROUNDWATER ELEVATIONS
SEPTEMBER 2003
REICHHOLD/GLACIER
5900 W. MARGINAL WAY S.W.
SEATTLE, WASHINGTON



MW22

CONC.	DEPTH
160	5' - 5.5'
5.7	8.5' - 9'
7.9	13' - 13.5'

MW23

CONC.	DEPTH
7.2	5' - 5.5'
<4.2	8.5' - 9'
<6.2	13' - 13.5'

MW24

CONC.	DEPTH
<4.2	3.5' - 4'
<4.0	8.5' - 9'
<5.9	13' - 13.5'

MW25

CONC.	DEPTH
<2.7	3.5' - 4'
11	8' - 8.5'
<7.8	13' - 13.5'

MW26

CONC.	DEPTH
180	5' - 5.5'
9.1	8' - 8.5'
250	10.5' - 11'
24	13' - 13.5'

MW27

CONC.	DEPTH
<3.6	5.5' - 6'
<3.7	8' - 8.5'
<4.4	10.5' - 11'
<3.6	13' - 13.5'

SOURCE: GLACIER NORTHWEST

Topographic information shown is derived from photogrametric mapping performed by Nies Mapping Group, project 99098. Date of photo is 4-13-99. Contour interval is 2 feet.

LEGEND:

- Existing Monitoring Well (RETEC, 1995)
- Test Pit Locations (RETEC, 1995)
- Geoprobe Locations (RETEC, 1995)
- Arsenic Treatment Area
- Arsenic Concentrations >25 mg/kg
- Shaw (2003)
- Fluor Daniel GTI (1998)
- Fluor Daniel GTI (1997)
- Ozone Sparge Remediation Trailer

CONC.	DEPTH
<2.7	3.5' - 4'

Post Treatment Total Arsenic Concentration (mg/kg) In Soil (mg/kg = milligrams per kilogram)

Note: All locations are approximate.

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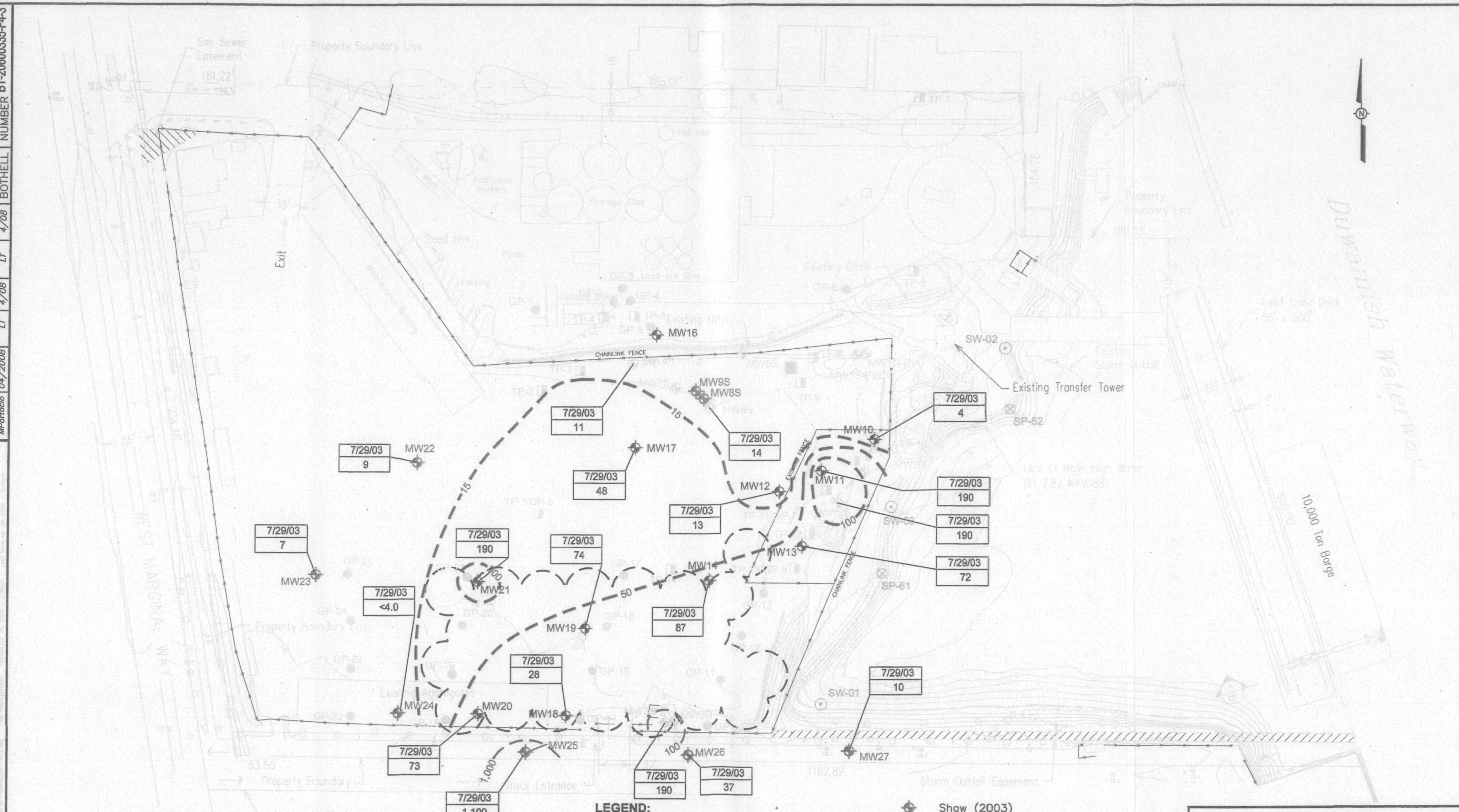
FIGURE 4-2
POST TREATMENT TOTAL ARSENIC CONCENTRATIONS IN SOIL
REICHHOLD/GLACIER
5900 W. MARGINAL WAY S.W.
SEATTLE, WASHINGTON



SCALE

0 100 200 FEET

SOURCE: GLACIER NORTHWEST

Topographic information shown is derived from photogrammetric mapping performed by Nies Mapping Group, project 99098. Date of photo is 4-13-99. Contour interval is 2 feet.

LEGEND:

- Existing Monitoring Well (RETEC, 1995)
- Test Pit Locations (RETEC, 1995)
- Geoprobe Locations (RETEC, 1995)
- μg/L = micrograms per liter
- Arsenic Treatment Area
- 50 Estimated Groundwater Contours of Dissolved Arsenic Concentrations
- Shaw (2003)
- Fluor Daniel GTI (1998)
- Fluor Daniel GTI (1997)
- Ozone Sparge Remediation Trailer
- Seep Sample Location (Winward, 2004)
- Seep Water Sample Location (Hart Crowser, 1995)
- 7/29/03 48 Dissolved Arsenic Concentrations in μg/L

Note: All locations are approximate.

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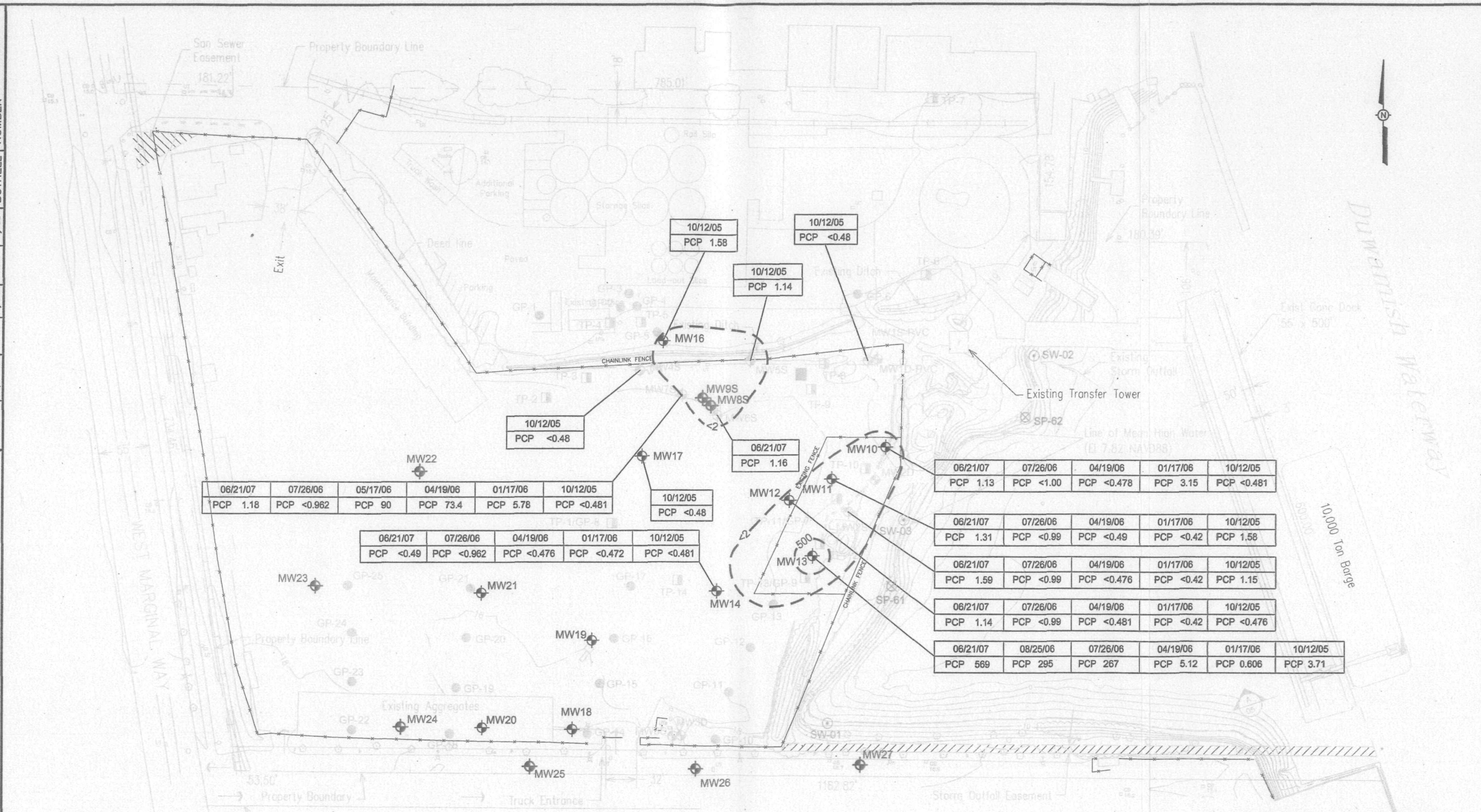
FIGURE 4-3
POST TREATMENT DISSOLVED ARSENIC CONCENTRATIONS IN GROUNDWATER
REICHHOLD/GLACIER
5900 W. MARGINAL WAY S.W.
SEATTLE, WASHINGTON



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SCALE

0 100 200 FEET

SOURCE: GLACIER NORTHWEST

Topographic information shown is derived from photogrametric mapping performed by Nies Mapping Group, project 99098. Date of photo is 4-13-99. Contour interval is 2 feet.

LEGEND:

- Existing Monitoring Well (RETEC, 1995)
- Test Pit Locations (RETEC, 1995)
- Geoprobe Locations (RETEC, 1995)
- Estimated PCP Concentration Groundwater Contour to <2 μg/L
- Seep Water Sample Location (Hart Crowser, 1995)
- Seep Sample Location (Windward, 2004)
- Shaw (2003)
- Fluor Daniel GTI (1998)
- Fluor Daniel GTI (1997)
- Ozone Sparge Remediation Trailer
- 10/12/05 PCP <0.49 — Post Treatment Pentachlorophenol Concentration (μg/L) In Groundwater

Note: All locations are approximate.

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FIGURE 5-1
POST TREATMENT PENTACHLOROPHENOL CONCENTRATIONS IN GROUNDWATER
REICHHOLD/GLACIER
5900 W. MARGINAL WAY S.W.
SEATTLE, WASHINGTON

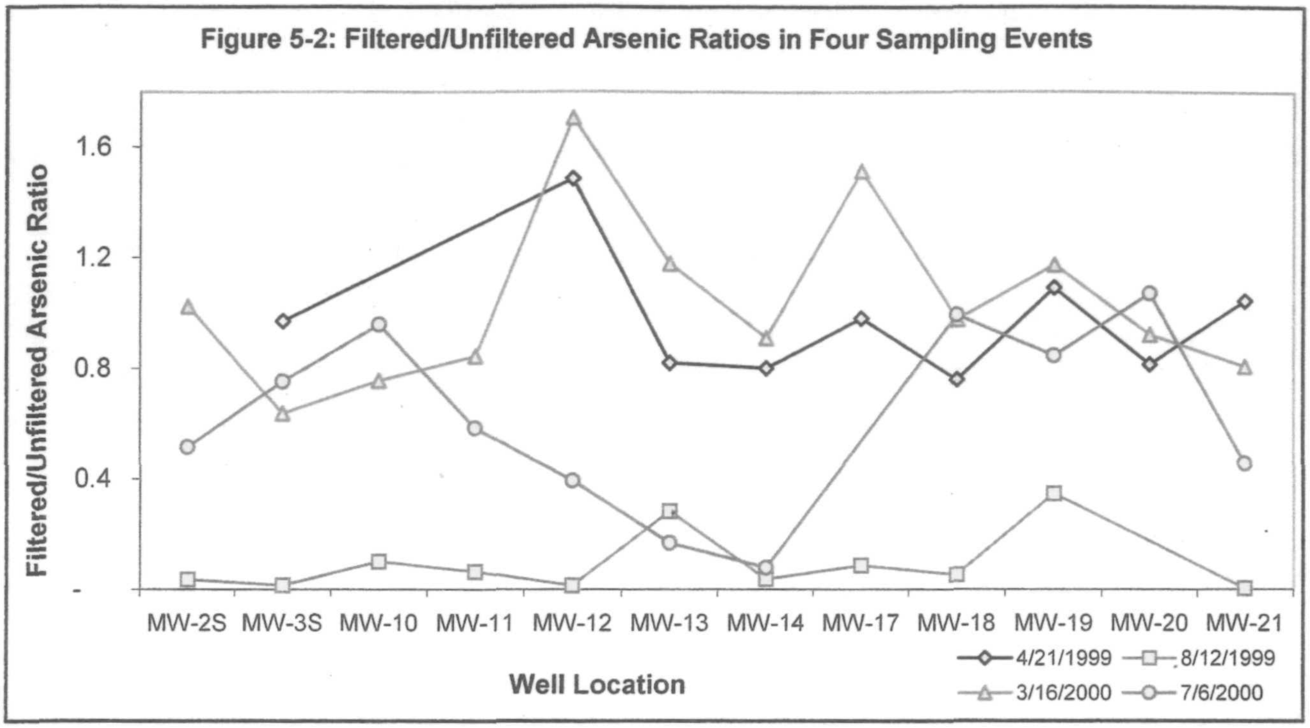


Figure 5-2: Filtered/Unfiltered Arsenic Ratios in Four Sampling Events
Filtered/Unfiltered Arsenic Ratio
1.6
1.2
0.8
0.4
-
MW-2S MW-3S MW-10 MW-11 MW-12 MW-13 MW-14 MW-17 MW-18 MW-19 MW-20 MW-21
Well Location
4/21/1999
8/12/1999
3/16/2000
7/6/2000

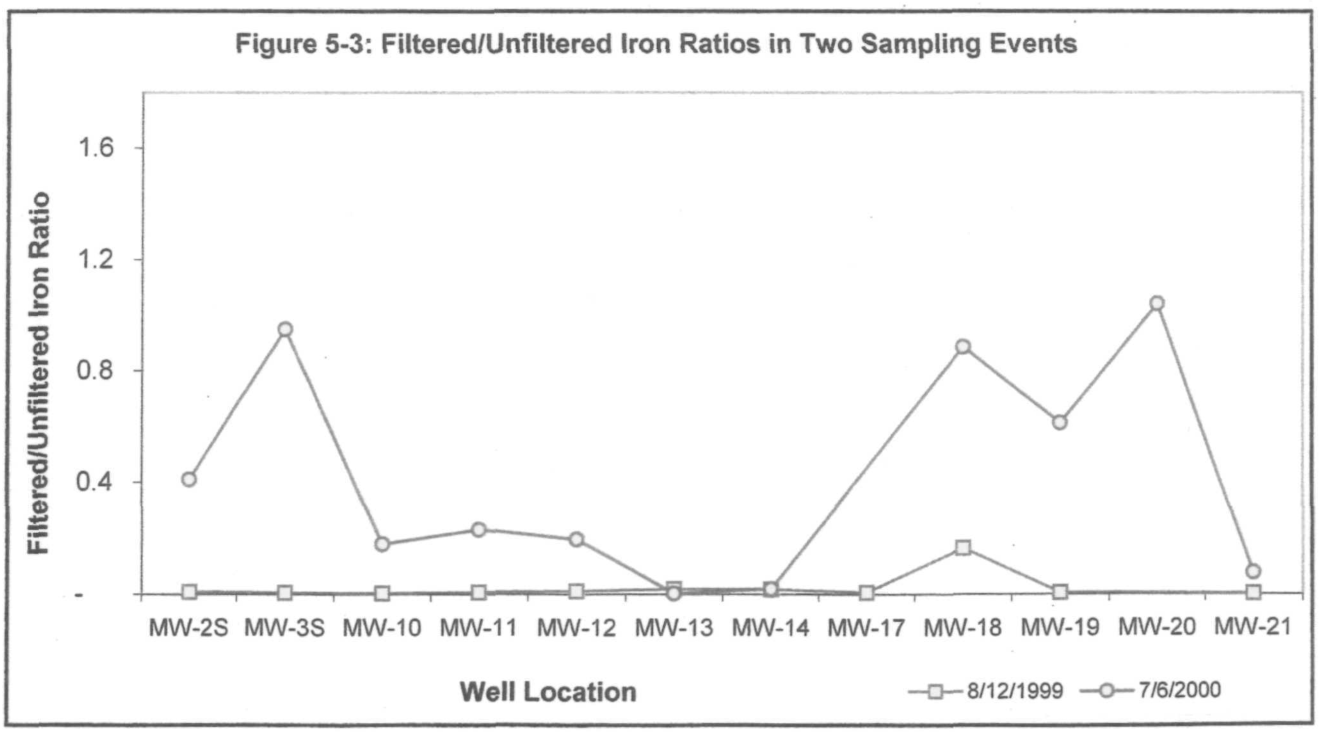


Figure 5-3: Filtered/Unfiltered Iron Ratios in Two Sampling Events
Filtered/Unfiltered Iron Ratio
1.6
1.2
0.8
0.4
-
MW-2S MW-3S MW-10 MW-11 MW-12 MW-13 MW-14 MW-17 MW-18 MW-19 MW-20 MW-21
Well Location
8/12/1999
7/6/2000

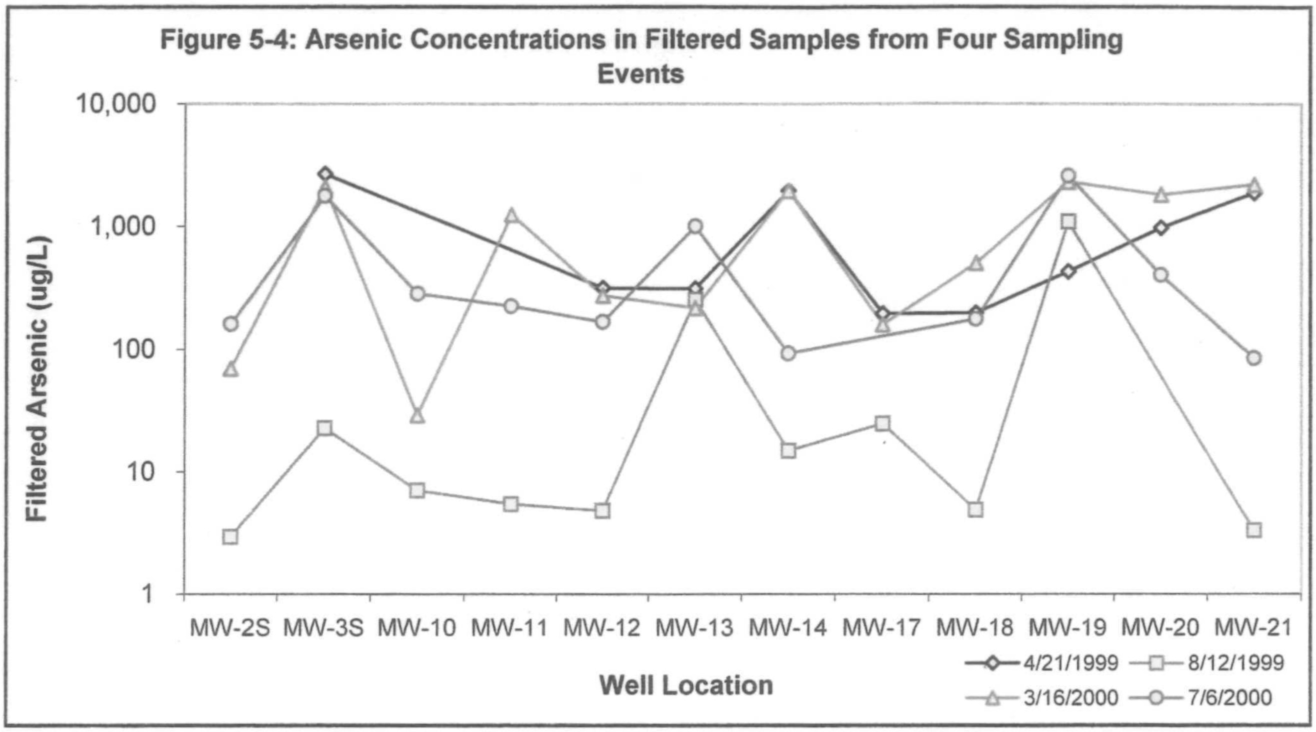
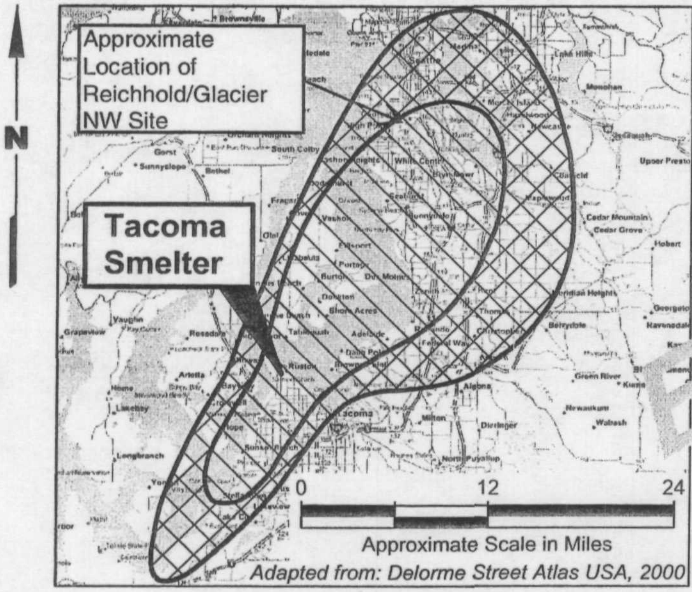
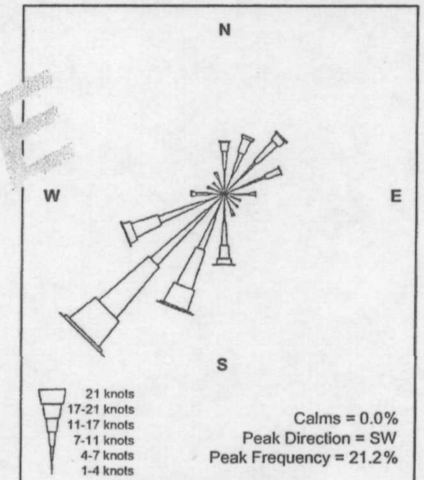


Figure 5-4: Arsenic Concentrations in Filtered Samples from Four Sampling Events
10,000
1,000
100
10
1
Filtered Arsenic (ug/L)
MW-2S
MW-3S
MW-10
MW-11
MW-12
MW-13
MW-14
MW-17
MW-18
MW-19
MW-20
MW-21
Well Location
4/21/1999
8/12/1999
3/16/2000
7/6/2000

Figure 5-5: Estimate of Area Affected by Historical Tacoma Smelter Emissions with Wind Rose Diagram of Predominant Wind Directions at the Smelter Site (Based on Data Available as of January 2003)





Wind Rose Data
From 1/1/82 - 12/31/82
Source: Asarco Information Center
Station Location: Tacoma Smelter

Legend

Level 1: Area where shallow undisturbed soil likely exceeds 20 mg/kg Arsenic

Level 2: Area where shallow undisturbed soil occasionally exceeds 20 mg/kg Arsenic

Data Sources:
Ecology, 2002
Glass, 2002

Disclaimer

This map should not substitute for a site-specific assessment. Not all of the areas identified on the map will actually have elevated levels of arsenic and lead in soil. Some properties outside of the identified areas may have elevated levels of arsenic and lead in soil.

The map of the area affected by smelter emissions was originally developed in 2003 for the report "Area-wide Soil Contamination Project, Task 3.4: Preliminary Estimates." They are based on information available at that time and are intended to provide a general indication of where elevated levels of arsenic and lead in soil may be present due to historical smelter emissions, so individuals and communities can assess whether to look into additional information on area-wide soil contamination.

Interpreting a Wind Rose

A wind rose is a quantitative graphical summary of the wind direction and speed for a given time. The wind rose diagram shows the number of hours (expressed as a percentage) that the wind blew from a particular direction and speed. The wind rose spokes or arms represent 16 points of the compass. The length of each segment of a spoke represents the percentage of time the wind speed was within a specific speed interval for a particular direction (the longer the spoke, the greater the time that the wind blew from that direction). If summed for all wind directions, the result would provide the percentage of all hours the wind speed was measured within a specific interval. The percentage of time when the winds were light and variable is shown in the center of the rose.

APPENDIX A

Copies of Data Tables from RETEC RI Report

REI IEC

TABLE 4-2
ANALYTICAL SOIL SAMPLING SUMMARY
LONE STAR/REICHHOLD SITE
REMEDIAL INVESTIGATION

Area	Sample Location	Depth	Immunoassay PCP	Chlorinated Phenols	Arsenic	Silver	TPH	Formaldehyde	TOC
Tank Farm									
	TP-1	4-5	x	x	x	x			
		5-6	x						
		6-7	x						
	TP-2	3-4	x						
		4-5	x	x	x	x		x	
		5-6	x	x	x	x			
		6-7	x						
	GP-1	3-4	x	x	x	x			
		7-8	x						
		11-12	x	x	x	x			
Wastewater Impoundment									
	TP-10	2-3	x	x	x	x			
		4-5	x						
		6-7	x	x	x	x			
	TP-11	2-3	x						
		3-4	x	x	x	x			
		5-6	x						
		6-7	x	x	x	x			
	TP-12	2-3	x						
		4-5	x						
		6-7	x	x	x	x			
	GP-7	7-8	x	x	x	x			
		9-10	x	x	x	x			
		15-16	x	x	x	x			
	MW-2S	10-11		x	x	x			
	MW-2D	10-11		x	x	x			
		17-18		x	x	x			
PCP Production Area									
	TP-3	2-3	x	x	x	x			
		3-4	x	x	x	x			
		5-6	x				x		
	TP-4	0-1	x	x	x	x			
		2-3	x						
	TP-5	0-1	x						
		2-3	x	x	x	x			
	GP-5	2-3	x						
		3-4	x	x	x	x			
		7-8	x	x	x	x			
		11-12	x	x	x	x			
	MW-4S	10-11		x	x	x			

TABLE 4-2 (Continued)
ANALYTICAL SOIL SAMPLING SUMMARY
LONE STAR/REICHHOLD SITE
REMEDIAL INVESTIGATION

REITEC

Area	Sample Location	Depth	Immunoassay PCP	Chlorinated Phenols	Arsenic	Silver	TPH	Formaldehyde	TOC
Original PCP Pilot Area									
	TP-8	2-3	x	x	x	x			
		4-5	x						
		5-6	x						
	TP-9	3-4	x	x	x	x		x	
		5-6	x	x	x	x			
		6-7	x						
Second PCP Pilot Area									
	GP-2	3-4	x	x	x	x			
		7-8	x						
		13-14		x	x	x			
	GP-3	3-4	x	x	x	x			
		7-8	x	x	x	x			
		15-16	x						
	GP-4	3-4	x	x	x	x			
		7-8	x						
		15-16	x						
Septic Tank									
	TP-7	0-1	x						
		1-2	x						
		2-3		x	x	x			
		3-4	x						
Former North Ditches (N)									
	TP-6	0-1	x	x	x	x			
		1-2	x						
		3-4	x						
Former North Ditches (S)									
	GP-6	1-2	x						
		3-4	x	x	x	x			
		7-8	x						
		11-12	x						
Former South Ditch									
	TP-13	3-4	x						
		4-5	x						
		6-7	x	x	x	x			
	TP-14	3-4	x	x	x	x			
		4-5	x						
		5-6	x						
		7-8	x						
	GP-9	8-9	x						
		11-12	x	x	x	x			

REITEC

TABLE 4-2 (Continued)
ANALYTICAL SOIL SAMPLING SUMMARY
LONE STAR/REICHHOLD SITE
REMEDIAL INVESTIGATION

Area	Sample Location	Depth	Immunoassay PCP	Chlorinated Phenols	Arsenic	Silver	TPH	Formaldehyde	TOC
Other									
	MW-5S	5-6.5		x					x
		7.5-9		x					x
	MW-6S	5-6.5		x					x
		7.5-9		x					x
	MW-7S	5-6.5		x					x
		7.5-9		x					x

NOTE:
MW-5S labelled as MW-8S on analytical report.

RETEC

TABLE 5-1
WATER LEVEL GAUGING DATA
LONE STAR/REICHHOLD SITE
REMEDIAL INVESTIGATION

Well Number	TOC Elevation (feet)	TOS Elevation (feet)	Parameter	12/11/95	01/22/96	04/11/96	04/24/96
MW-1S	8.29	5.8	Time	14:02	15:43	09:59	11:00
			Depth to GW (feet)	5.55	6.07	7.70	6.01
			GW Elevation (feet)	2.74	2.22	0.59	2.28
MW-1D	7.76	5.6	Time	14:05	15:41	10:01	NM
			Depth to GW (feet)	10.82	11.39	13.58	NM
			GW Elevation (feet)	-3.06	-3.63	-5.82	NM
MW-2S	8.02	6.1	Time	14:12	15:38	10:05	10:30
			Depth to GW (feet)	5.75	5.89	7.55	6.11
			GW Elevation (feet)	2.27	2.13	0.47	-6.11
MW-2D	8.06	6.3	Time	14:10	15:36	10:03	NM
			Depth to GW (feet)	11.15	11.60	11.79	NM
			GW Elevation (feet)	-3.09	-3.54	-3.73	NM
MW-3S	10.19	8.0	Time	14:20	07:26	10:11	10:00
			Depth to GW (feet)	10.94	9.95	11.12	10.81
			GW Elevation (feet)	-0.75	0.24	-0.93	-10.81
MW-3D	10.09	7.9	Time	14:15	15:29	10:09	NM
			Depth to GW (feet)	12.93	13.76	13.95	NM
			GW Elevation (feet)	-2.84	-3.67	-3.86	NM
MW-4S	9.42	6.9	Time	14:30	15:47	09:44	01:00
			Depth to GW (feet)	6.60	6.87	8.24	7.05
			GW Elevation (feet)	2.82	2.55	1.18	-7.05
MW-5S	9.05	6.7	Time	NM	NM	09:54	11:30
			Depth to GW (feet)	NM	NM	8.07	6.73
			GW Elevation (feet)	NM	NM	0.98	-6.73
MW-6S	9.11	7.1	Time	NM	NM	09:50	12:00
			Depth to GW (feet)	NM	NM	8.07	7.07
			GW Elevation (feet)	NM	NM	1.04	-7.07
MW-7S	9.11	7.2	Time	NM	NM	09:47	12:30
			Depth to GW (feet)	NM	NM	8.00	6.92
			GW Elevation (feet)	NM	NM	1.11	-6.92
Pier	5.80		Time	NM	15:55	09:39	NM
			Depth to Water (feet)	NM	7.85	9.12	NM
			Water Elevation (feet)	NM	-2.05	-3.32	NM

NOTES:

Wells MW-5S, 6S, 7S, installed 4/10/96.

Elevations surveyed relative to City of Seattle datum.

NM - Not Measured

TABLE 5-2
VERTICAL GRADIENTS BETWEEN SATURATED ZONES
1/25/96 TIDAL STUDY

Tidal Stage	Tide (feet above MLLW)	Vertical Gradient (feet/foot)			
		MW-1S/1D	MW-2S/2D	MW-3S/3D	Average
Low-Low Tide 1/25/96 02:45	1.8	0.67	0.70	0.36	0.58
High-High Tide 1/25/96 09:45	12.7	0.29	0.29	0.19	0.26

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TABLE 5-3
SOIL ANALYTICAL RESULTS
DECEMBER 1995
LONE STAR/REICHHOLD SITE
REMEDIAL INVESTIGATION

Analyte / Sample Depth	TP-1 4-5	TP-2 4-5	TP-2 5-6	TP-3 2-3	TP-3 3-4	TP-3 5-6	TP-4 0-1	TP-5 2-3	TP-6 0-1	TP-7 2-3
Chlorinated Phenols (μg/kg)										
2-chlorophenol	< 160	< 240	< 180	< 180	< 230	< 220	< 160	< 190	< 190	< 1,900
2,4-dichlorophenol	< 70	< 110	< 79	< 80	< 230	< 99	< 73	< 86	< 85	< 860
2,4,6-trichlorophenol	< 140	< 210	< 160	< 160	< 230	< 190	< 140	< 170	< 170	< 1,700
2,4,5-trichlorophenol	< 140	< 220	< 160	< 160	< 230	< 200	< 150	< 170	< 170	< 1,700
pentachlorophenol	< 280	< 430	< 310	< 320	< 1,200	< 390	< 290	5,000	< 340	< 3,400
2,3,4,6-tetrachlorophenol	< 140	< 210	< 160	< 160	< 230	< 190	< 140	< 170	< 170	< 1,700
2,3,5,6-tetrachlorophenol	< 140	< 210	< 160	< 160	< 230	< 190	< 140	67 J	< 170	< 1,700
Metals (mg/kg)										
arsenic	77	< 21	< 17	< 15	50	< 22	36	< 16	48	< 19
silver	1.5	< 1.4	< 1.2	< 0.99	< 2.1	< 1.4	< 1.0	< 1.0	< 1.1	< 1.3

Analyte / Sample Depth	TP-8 2-3	TP-9 3-4	TP-9 5-6	TP-10 2-3	TP-10 6-7	TP-11 3-4	TP-11 6-7	TP-12 6-7	TP-13 6-7	TP-14 3-4
Chlorinated Phenols (μg/kg)										
2-chlorophenol	< 250	< 300	< 190	180 J	< 190	65 J	< 4,200 J	< 180	< 180	< 250
2,4-dichlorophenol	< 110	< 140	< 86	< 90	< 86	< 75	< 1,900	< 79	< 82	< 110
2,4,6-trichlorophenol	< 220	< 270	< 170	< 180	< 170	< 150	< 3,600	< 150	< 160	< 220
2,4,5-trichlorophenol	< 230	< 270	< 170	< 180	< 170	< 150	< 3,700	< 160	< 160	< 230
pentachlorophenol	< 450	< 540	< 340	1,900	980	< 300	210,000	1,000	270 J	< 450
2,3,4,6-tetrachlorophenol	< 220	< 270	< 170	< 180	< 170	< 150	< 3,600	< 150	< 160	< 220
2,3,5,6-tetrachlorophenol	< 220	< 270	< 170	110 J	67 J	< 150	5,600	< 150	< 160	< 220
Metals (mg/kg)										
arsenic	< 23	< 24	28	< 18	< 16	15	< 17	30	120	90
silver	< 1.5	< 1.6	< 1.3	2.0	< 1.1	< 0.96	< 1.1	< 1.1	< 1.1	< 1.5

TABLE 5-3 (Continued)
SOIL ANALYTICAL RESULTS
DECEMBER 1995
LONE STAR/REICHHOLD SITE
REMEDIAL INVESTIGATION

Sample	GP-1	GP-1	GP-2	GP-2	GP-3	GP-3	GP-4	GP-5	GP-5
Analyte / Depth	3-4	11-12	3-4	13-14	3-4	7-8	3-4	3-4	7-8
Chlorinated Phenols (µg/kg)									
2-chlorophenol	< 240	< 260	< 220	< 650	< 230	< 240	< 220	< 230	< 240
2,4-dichlorophenol	< 240	< 260	< 220	< 650	< 230	< 240	< 220	< 230	< 240
2,4,6-trichlorophenol	< 240	< 260	< 220	< 650	< 230	< 240	< 220	< 230	< 240
2,4,5-trichlorophenol	< 240	< 260	< 220	780	< 230	< 240	< 220	< 230	< 240
pentachlorophenol	< 1,200 J	< 1,300	2,200	69,000	240 J	< 1,200	< 1,100	250 J	< 1,200
2,3,4,6-tetrachlorophenol	< 240	< 260	< 220	< 650	< 230	< 240	< 220	< 230	< 240
2,3,5,6-tetrachlorophenol	< 240	< 260	340	5,000	< 230	< 240	< 220	< 230	< 240
Metals (mg/kg)									
arsenic	< 5.5	< 6.5	< 5.5	11	13	< 6.2	< 5	< 5.9	< 5.7
silver	< 2.2	< 2.6	< 2.2	< 3.1	< 2.4	< 2.5	< 2.0	< 2.3	< 2.3

Sample	GP-5	GP-6	GP-7	GP-7	GP-7	GP-9	MW-2S	MW-2D	MW-2D
Analyte / Depth	11-12	3-4	7-8	9-10	15-16	11-12	10-11	10-11	17-18
Chlorinated Phenols (µg/kg)									
2-chlorophenol	< 320	< 250	91 J	< 250	110 J	< 290	220 J	< 280	< 230
2,4-dichlorophenol	< 320	< 250	420	< 250	< 300	< 290	< 350	< 280	< 230
2,4,6-trichlorophenol	< 320	< 250	220 J	< 250	< 300	< 290	< 350	< 280	< 230
2,4,5-trichlorophenol	< 320	< 250	< 240	< 250	< 300	< 290	< 350	< 280	< 230
pentachlorophenol	< 1,600	< 1,300	830,000	880	2,000	< 1,500	< 1,700	< 1,400	< 1,100
2,3,4,6-tetrachlorophenol	< 320	< 250	< 240	< 250	< 300	< 290	< 350	< 280	< 230
2,3,5,6-tetrachlorophenol	< 320	< 250	98,000	< 250	< 300	< 290	< 350	< 280	< 230
Metals (mg/kg)									
arsenic	10	< 5.7	15	8.7	85	1,100	18	13.0	< 5.7
silver	< 3.2	< 2.3	< 2.6	< 2.2	< 3.2	< 2.9	< 3.2	< 2.7	< 2.3

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TABLE 5-3 (Continued)
SOIL ANALYTICAL RESULTS
DECEMBER 1995
LONE STAR/REICHHOLD SITE
REMEDIAL INVESTIGATION

Analyte / Sample Depth	MW-4S 10-11	MW-5S 5-6.5	MW-5S 7.5-9	MW-6S 5-6.5	MW-6S 7.5-9	MW-7S 5-6.5	MW-7S 7.5-9
Chlorinated Phenols (µg/kg)							
2-chlorophenol	< 320	NA	NA	NA	NA	NA	NA
2,4-dichlorophenol	< 320	NA	NA	NA	NA	NA	NA
2,4,6-trichlorophenol	< 320	NA	NA	NA	NA	NA	NA
2,4,5-trichlorophenol	< 320	NA	NA	NA	NA	NA	NA
pentachlorophenol	< 1,600	< 14	54	< 17	< 15	1,800	420
2,3,4,6-tetrachlorophenol	< 320	NA	NA	NA	NA	NA	NA
2,3,5,6-tetrachlorophenol	< 320	NA	NA	NA	NA	NA	NA
Metals (mg/kg)							
arsenic	8.4	NA	NA	NA	NA	NA	NA
silver	< 2.8	NA	NA	NA	NA	NA	NA

NOTES:

Chlorinated phenols analyzed using EPA method 8270.

Arsenic and silver analyzed using EPA method 6020.

Samples TP-2 4-5 and TP-9 3-4 also analyzed for formaldehyde which was not detected in either sample; detection limit = 10 mg/kg.

Sample TP-3 5-6 also analyzed for total petroleum hydrocarbons using method WTPH-HCID; gasoline-, diesel-, and heavy oil-hydrocarbons were not detected above reporting limits of 20, 50 and 100 mg/kg, respectively.

J - Constituent detected below method detection limit; therefore concentration presented is an estimated quantity.

NA - Not Analyzed

MW-5S labelled as MW-8S on analytical report.

TABLE 5-4
ARSENIC CONCENTRATIONS
GEOPROBE INVESTIGATION - 3/26/96
LONE STAR/REICHHOLD SITE
REMEDIAL INVESTIGATION

	Soil (mg/kg)	Groundwater (mg/L)
GP-10	320	0.26
GP-11	99	0.10
GP-12	140	0.76
GP-13	120	0.75
GP-14	28	2.3
GP-15	140	1.7
GP-16	66	2.8
GP-17	NS	NS
GP-18	< 21	0.67
GP-19	93	1.3
GP-20	60	1.9
GP-21	< 21	0.12
GP-22	< 21	0.007
GP-23	< 24	0.013
GP-24	< 22	0.13
GP-25	< 21	0.012
GP-101	36	2.3
GP-102	< 21	0.11

NOTES:
All soil samples collected from 7 to 9 feet bgs.
Arsenic concentrations in groundwater are dissolved arsenic.
NS - Not sampled due to impenetrable gravel.
GP-101 is a duplicate of GP-14.
GP-102 is a duplicate of GP-21.

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TABLE 5-5
GROUNDWATER ANALYTICAL RESULTS
DECEMBER 1995, JANUARY & APRIL 1996
LONE STAR/REICHHOLD SITE
REMEDIAL INVESTIGATION

Sample / Date / Analyte	MW-1S 12/11/95	MW-1S 4/18/96	MW-1D 12/11/95	MW-2S 12/11/95	MW-2S 1/30/96	MW-2S 4/18/96	MW-2D 12/11/95	MW-3S 12/11/95	MW-3S 1/30/96	MW-3S 4/18/96
Chlorinated Phenols (μg/L)										
2,4-dichlorophenol	< 0.99	< 0.099	< 1.2	< 1.3	NA	0.073 J	< 1	< 1	NA	< 0.099
2,4,6-trichlorophenol	< 0.99	< 0.099	< 1.2	< 1.3	NA	< 0.099	< 1	< 1	NA	< 0.099
2,4,5-trichlorophenol	< 0.99	< 0.099	< 1.2	< 1.3	NA	< 0.099	< 1	< 1	NA	< 0.099
pentachlorophenol	0.77 J	< 0.5	< 5.9	42	NA	0.49 J	< 5.2	< 5.1	NA	< 0.5
2,3,4,6-tetrachlorophenol	< 0.99	0.035 J	< 1.2	2.1	NA	< 0.099	< 1	< 1	NA	< 0.099
Metals (mg/L)										
arsenic (total)	0.045	NA	0.011	0.20	0.14	NA	0.007	7.4	2.2	NA
arsenic (dissolved)	NA	NA	NA	NA	0.26	NA	NA	NA	6.0	NA
silver	< 0.002	NA	< 0.002	< 0.002	NA	NA	< 0.002	< 0.002	NA	NA
formaldehyde (mg/L)	NA	NA	NA	1.3	NA	NA	NA	NA	NA	NA

NOTES:

* MW-5D is a duplicate of MW-4S on 12/11/95. MW-10S is a duplicate of MW-6S on 4/18/96.
Chlorinated phenols analyzed using EPA method 8270.
Arsenic and silver analyzed using EPA method 6020.
Formaldehyde analyzed using ASTM method D-19.
NA - Not Analyzed
J - Constituent detected below method detection limit; therefore, concentration presented is an estimated quantity.

TABLE 5-5 (Continued)
GROUNDWATER ANALYTICAL RESULTS
DECEMBER 1995, JANUARY & APRIL 1996
LONE STAR/REICHHOLD SITE
REMEDIAL INVESTIGATION

Sample Date Analyte	MW-3D 12/11/95	MW-3D 1/30/96	MW-4S 12/11/95	MW-4S 4/18/96	MW-5S 4/18/96	*MW-5D 12/11/95	MW-6S 4/18/96	MW-7S 4/18/96	*MW-10S 4/18/96
Chlorinated Phenols (µg/L)									
2,4-dichlorophenol	< 1.1	NA	< 1	< 0.1	< 0.099	< 1	< 0.1	0.067 J	< 0.099
2,4,6-trichlorophenol	< 1.1	NA	< 1	< 0.1	< 0.099	< 1	< 0.1	0.12	< 0.099
2,4,5-trichlorophenol	< 1.1	NA	< 1	< 0.1	< 0.099	< 1	< 0.1	0.71	< 0.099
pentachlorophenol	< 5.4	NA	110	300	< 0.5	100	0.32 J	310	0.33 J
2,3,4,6-tetrachlorophenol	< 1.1	NA	4.8	5.1	< 0.099	5.4	0.076 J	22	0.061 J
Metals (mg/L)									
arsenic (total)	0.12	0.16	0.013	NA	NA	0.014	NA	NA	NA
arsenic (dissolved)	NA	0.38	NA	NA	NA	NA	NA	NA	NA
silver	< 0.002	NA	< 0.002	NA	NA	< 0.002	NA	NA	NA
formaldehyde (mg/L)	NA	NA	NA	NA	NA	NA	NA	NA	NA

NOTES:
* MW-5D is a duplicate of MW-4S on 12/11/95. MW-10S is a duplicate of MW-6S on 4/18/96.
Chlorinated phenols analyzed using EPA method 8270.
Arsenic and silver analyzed using EPA method 6020.
Formaldehyde analyzed using ASTM method D-19.
NA - Not Analyzed
J - Constituent detected below method detection limit; therefore, concentration presented is an estimated quantity.

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TABLE 5-6
GROUNDWATER MONITORING RESULTS - APRIL 18, 1996
LONE STAR/REICHHOLD SITE
REMEDIAL INVESTIGATION

Parameter	Units	Monitoring Well MW-4S	MW-7S	MW-5S	MW-6S	MW-10S Dup. of 6S	MW-1S	MW-2S	MW-3S
Pentachlorophenol	µg/L	300	310	< 0.5	0.32	- -	< 0.5	0.49	< 0.5
Ammonia Nitrogen	mg/L	< 0.04	0.29	0.04	0.59	0.63	0.30	1.6	1.1
Nitrate Nitrogen	mg/L	0.10	< 0.05	0.13	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Nitrite Nitrogen	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Orthophosphate	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.29	1.7	0.06
Sulfate	mg/L	15	32	18	62	62	9	2	< 1
Sulfide	mg/L	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
COD	mg/L	< 5	12	12	14	13	10	29	30
Field Monitoring									
pH	units	5.86	5.60	6.00	6.14	- -	6.66	6.16	6.28
Oxidation Reduction	mV	84	-57	90	-15	- -	-145	-133	-114
Dissolved Oxygen	mg/L	1.73	0.72	0.59	0.88	- -	0.33	0.55	0.42

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TABLE 6-1
SUMMARY OF ANALYTICAL DATA - SOIL
LONE STAR/REICHHOLD SITE
REMEDIAL INVESTIGATION

Analyte	Number of Samples	Number of Detections	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected	Maximum Detected	MTCA Method C	
							Industrial Cleanup Value	100 × Groundwater (a)
Chlorinated Phenols (mg/kg)								
2-chlorophenol	39	5	0.16	4.20	0.065 J	0.220 J	17,500	NV
2,4-dichlorophenol	39	1	0.07	1.90	0.42	0.420	10,500	19.1
2,4,6-trichlorophenol	39	1	0.14	3.60	0.22 J	0.220 J	11,900	0.39
2,4,5-trichlorophenol	39	1	0.14	3.70	0.78	0.780	350,000	160
pentachlorophenol	45	16	0.014	3.40	0.054	830	1,090	0.49
2,3,4,6-tetrachlorophenol	39	0	0.14	3.60	---	---	105,000	48
2,3,5,6-tetrachlorophenol	39	7	0.14	1.70	0.067 J	98	NV	NV
Metals (mg/kg)								
arsenic	39	11	5.0	24	8.7	1,100	219	0.14
silver	39	1	0.96	3.2	2.0	2.0	17,500	---

NOTES:

a - See Table 6-2.
--- - Below detectable levels.
J - Estimated value below detection limit.
NV - No MTCA health-based value exists.

Shaw

APPENDIX B

Boring / Monitoring Well Logs

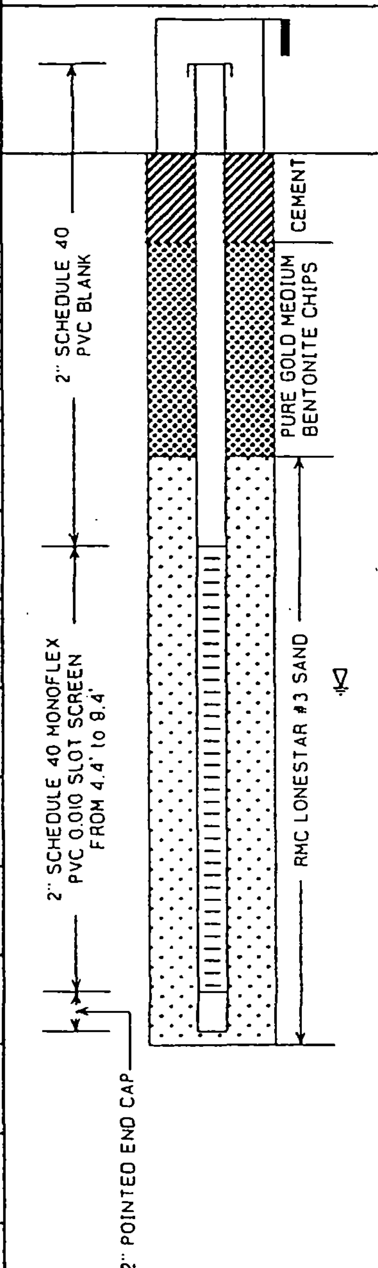
RETEC

BORING/WELL INSTALLATION LOG
Monitoring Well MW-1S

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA East of first pilot plant		DRILLING CO.: Cascade Drilling
START DATE: 12/06/95 TIME: 0945	BORING ID: 8"	DRILLER: S. Krueyer
COMPLETION DATE: 12/08/95 TIME: 0950	TOTAL DEPTH: 10'	RIG TYPE: CME
WATER LEVEL DURING DRILLING: 6' bgs	PVC STICK-UP: 2.49'	METHOD: HSA
SURFACE ELEV.: 5.8' MSL	MP ELEV.: 8.29' TOC PVC	LOGGED BY: A. Como

WELL CONSTRUCTION



DEPTH (in feet)	U.S.C.S.	SOIL DESCRIPTION	TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)
0		FILL: Grey gravel; pieces of concrete; some black sand					
5	SW	SAND: Fine to medium grained; well graded; black with some reddish brown grains; moist to wet at 6'	SS SS		15 17 18 8 9 9		
	ML	SILT: Slightly clayey; grey with some brown; organic material; low to medium plasticity; moist to wet					
10		Total Depth = 10 ft.					
15							

REMARKS: SS = Split Spoon

REMEDIATION TECHNOLOGIES, INC.
OFFICES NATIONWIDE

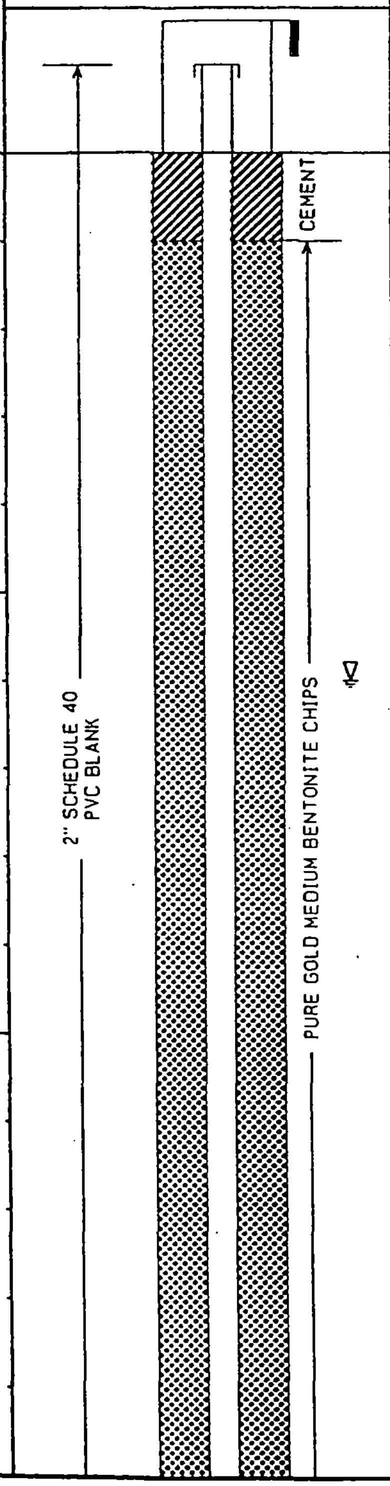
BORING/WELL INSTALLATION LOG

Monitoring Well MW-1D

RETEC
1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA East of first pilot plant		DRILLING CO.: Cascade Drilling
START DATE: 12/06/95 TIME: 0820	BORING ID: 8"	DRILLER: S. Krueyer
COMPLETION DATE: 12/06/95 TIME: 0910	TOTAL DEPTH: 26.5'	RIG TYPE: CME
WATER LEVEL DURING DRILLING: 6' bgs	PVC STICK-UP: 2.18'	METHOD: HSA
SURFACE ELEV.: 5.6' MSL	MP ELEV.: 7.78' TOC PVC	LOGGED BY: A. Como

WELL CONSTRUCTION



DEPTH (in feet)	U.S.C.S.	SOIL DESCRIPTION	TYPE	BLOWS /ft	%RECOVERY	PID (ppm)
0		FILL: Grey gravel; pieces of concrete; some black sand				
5	SW	SAND: Fine to medium grained; well graded; black with some reddish brown grains; moist to wet at 6'	SS	15 17 18		
			SS	8 9 9		
	ML	SILT: Slightly clayey; grey with some brown; organic material; low to medium plasticity; moist to wet				
10			SS	3 4 4		
		12.5' - grades to silt (less clay); some black sand on tip of sampler	SS	6 10 10		
15	SW					

REMARKS: SS = Split Spoon

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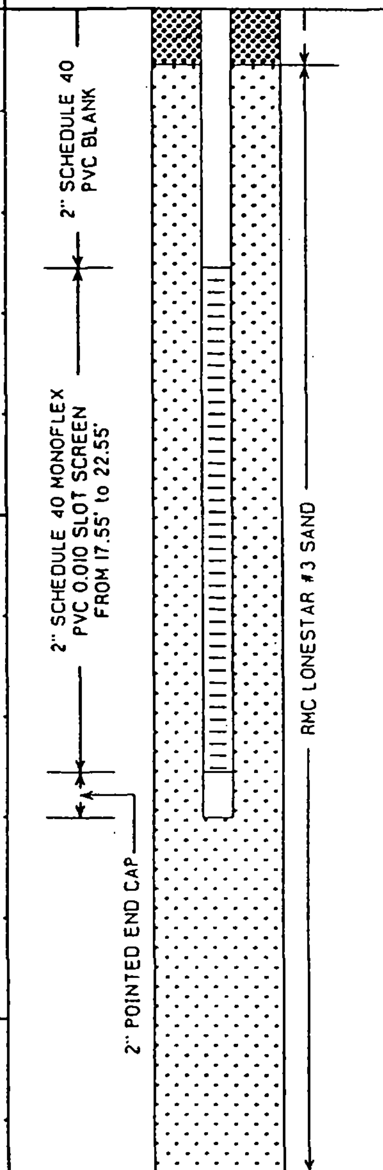
BORING/WELL INSTALLATION LOG

Monitoring Well MW-1D

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

WELL CONSTRUCTION



SOIL DESCRIPTION

DEPTH (in feet)	U.S.C.S.	SOIL DESCRIPTION
15	SW	SAND: Fine to medium grained; well graded; black; some fine gravel; moist to wet
20		20' – grades to fine to coarse sand with fine gravel
25		25' – becomes wet
26.5		Total Depth = 26.5 ft.
30		

SAMPLE DATA

TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)
SS	15	8, 5, 9		
SS	17.5	12, 14, 15		
SS	20	12, 15, 16		
SS	22.5	10, 12, 14		
SS	25	12, 15, 18		

REMARKS: SS = Split Spoon

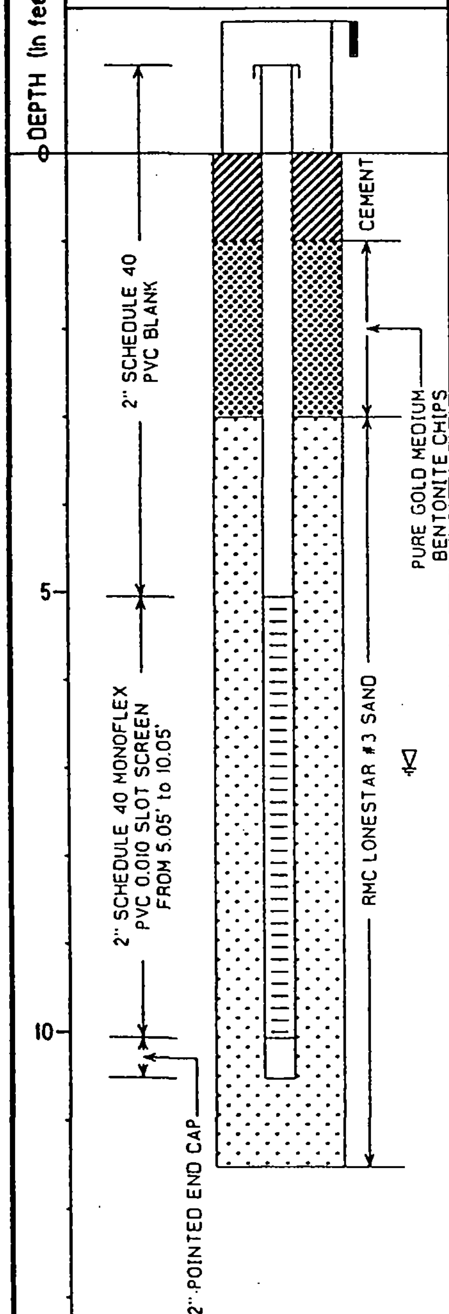
RETEC

BORING/WELL INSTALLATION LOG
Monitoring Well MW-2S

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA Former impoundment area		DRILLING CO.: Cascade Drilling
START DATE: 12/06/95 TIME: 1135	BORING ID: 8"	DRILLER: S. Krueyer
COMPLETION DATE: 12/06/95 TIME: 1210	TOTAL DEPTH: 11.5'	RIG TYPE: CME
WATER LEVEL DURING DRILLING: 7' bgs	PVC STICK-UP: 1.92'	METHOD: HSA
SURFACE ELEV.: 6.1' MSL	MP ELEV.: 8.02' TOC PVC	LOGGED BY: A. Como

WELL CONSTRUCTION



SOIL DESCRIPTION / SAMPLE DATA

U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)
		FILL: Grey gravel; pieces of concrete					
SP		SAND: Fine grained; poorly graded; black with some reddish brown grains; dry to moist;	SS		13 13 15		
		7' - becomes moist to wet	SS		9 11 15		
			SS		7 9 11		
CL		SILTY CLAY: Brown to grey; low to medium plasticity; organic material; moist	SS	■	9 11 13		
		Total Depth = 11.5 ft.					

REMARKS: SS = Split Spoon
■ = Analytical Sample

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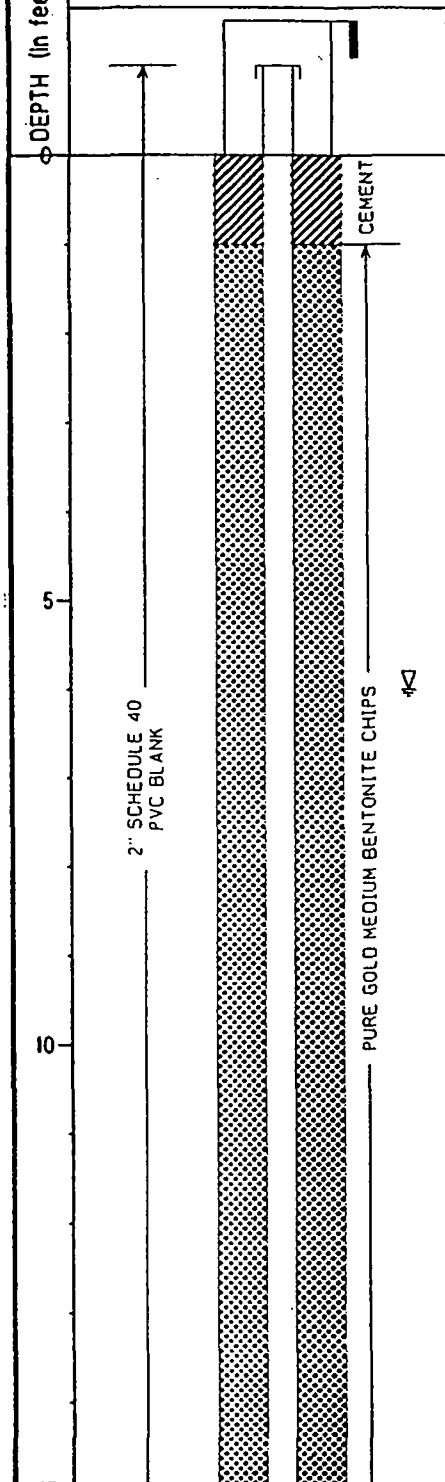
BORING/WELL INSTALLATION LOG
Monitoring Well MW-2D

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA Former impoundment area		DRILLING CO.: Cascade Drilling
START DATE: 12/06/95 TIME: 1030	BORING ID: 8"	DRILLER: S. Krueyer
COMPLETION DATE: 12/06/95 TIME: 1100	TOTAL DEPTH: 24'	RIG TYPE: CME
WATER LEVEL DURING DRILLING: 6' bgs	PVC STICK-UP: 1.76'	METHOD: HSA
SURFACE ELEV.: 6.3' MSL	MP ELEV.: 8.06' TOC PVC	LOGGED BY: A. Como

DEPTH (in feet) — WELL CONSTRUCTION



SOIL DESCRIPTION — SAMPLE DATA

U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)
		FILL: Grey gravel; pieces of concrete; sawdust at 4'					
SW		SAND: Fine to medium grained; well graded; black with some reddish brown grains; moist to wet at 6'	SS		22 24 26		
SP		SAND: Fine grained; poorly graded; black with some reddish brown grains; wet	SS		22 12 13		
CL		SILTY CLAY: Some organic material; low to medium plasticity; moist	SS		6 6 6		
			SS		8 15 16		
SP		SAND: Fine grained; poorly graded; grey to black; moist to wet					
ML							

REMARKS: SS = Split Spoon
∎ = Analytical Sample

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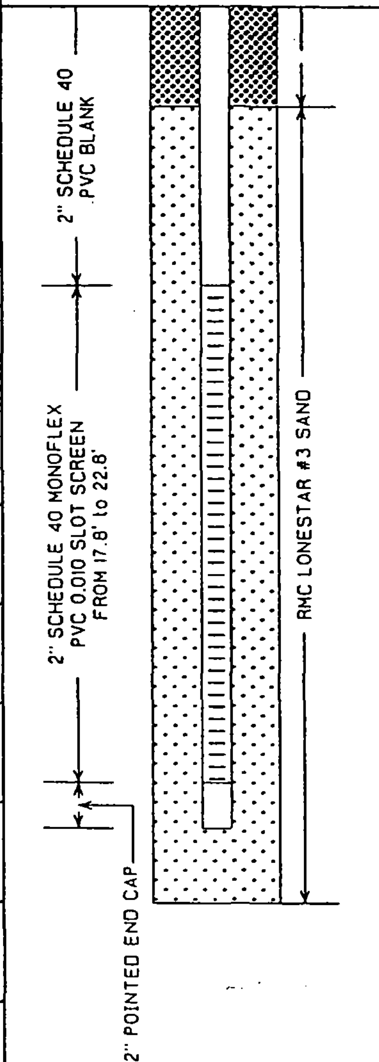
(206) 624-9349

BORING/WELL INSTALLATION LOG
Monitoring Well MW-2D

WELL CONSTRUCTION



DEPTH (in feet)	U.S.C.S.	SOIL DESCRIPTION	TYPE	BLOWS /ft	%RECOVERY	PID (ppm)
15	ML	SILT: Grey; moist to wet	SS	10 15 18		
	SW	SAND: Fine to medium grained; well graded; black with some reddish brown grains; wet				
			SS	18 20 22		
20			SS	20 21 22		
			SS	15 17 18		
		Total Depth = 24 ft.				
25						
30						

REMARKS: SS = Split Spoon
∎ = Analytical Sample

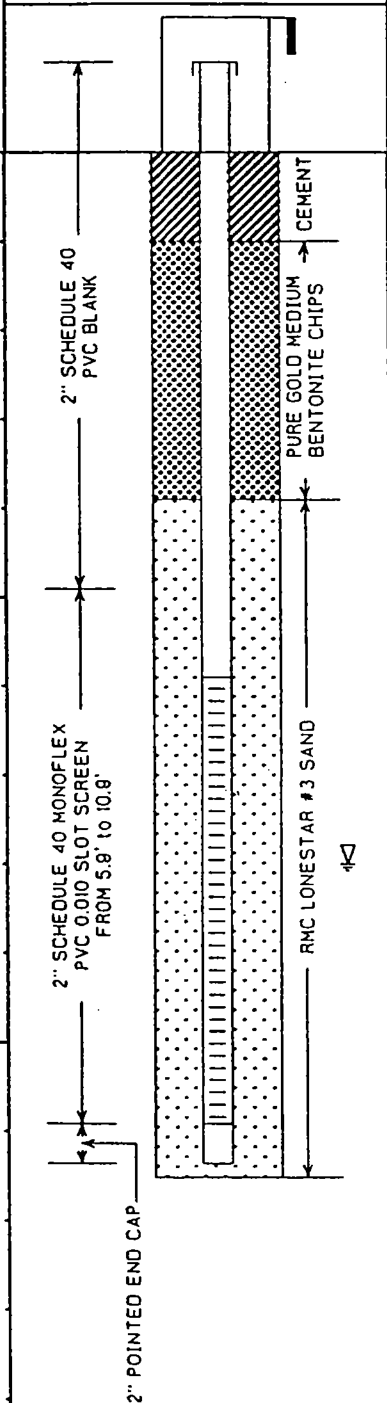
RETEC

BORING/WELL INSTALLATION LOG
Monitoring Well MW-3S

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA Southern property boundary		DRILLING CO.: Cascade Drilling
START DATE: 12/06/95 TIME: 1615	BORING ID: 8"	DRILLER: S. Krueyer
COMPLETION DATE: 12/06/95 TIME: 1625	TOTAL DEPTH: 11.5'	RIG TYPE: CME
WATER LEVEL DURING DRILLING: 8' bgs	PVC STICK-UP: 2.19'	METHOD: HSA
SURFACE ELEV.: 8' MSL	MP ELEV.: 10.19' TOC PVC	LOGGED BY: A. Como

DEPTH (in feet) | WELL CONSTRUCTION | SOIL DESCRIPTION | SAMPLE DATA



DEPTH (ft)	U.S.C.S.	SOIL DESCRIPTION	TYPE	BLOWS/ft	%RECOVERY	PID (ppm)
0		FILL: Grey gravel; pieces of concrete; sawdust at 3-5'				
5	SP	SAND: Fine grained; poorly graded; black with some reddish brown grains; dry	SS	12 15 16		
		8' - becomes moist to wet	SS	12 15 17		
10			SS	12 14 17		
11.5		Total Depth = 11.5 ft.				
15						

REMARKS: SS = Split Spoon

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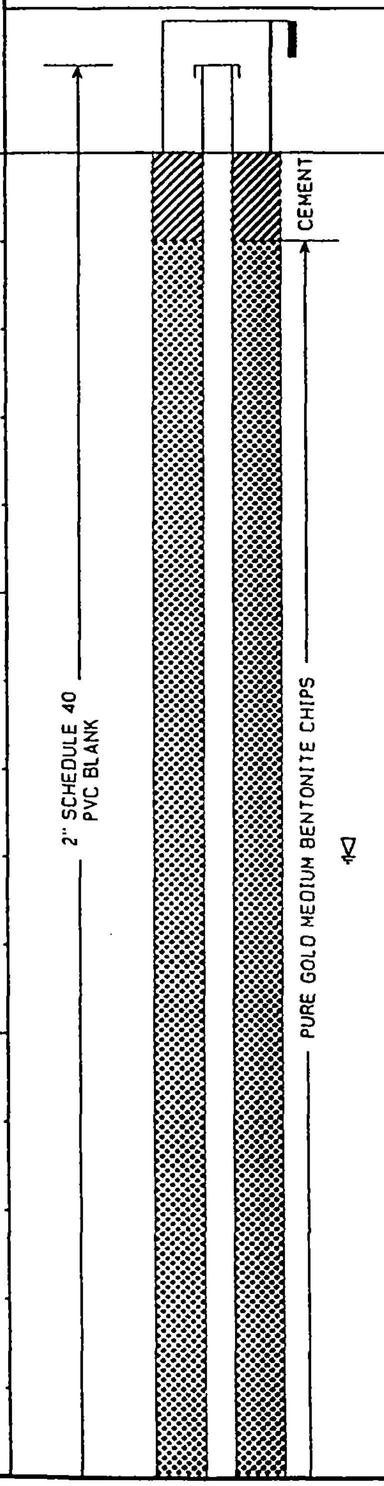
BORING/WELL INSTALLATION LOG
Monitoring Well MW-3D

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA Southern property boundary		DRILLING CO.: Cascade Drilling
START DATE: 12/06/95 TIME: 1430	BORING ID: 8"	DRILLER: S. Krueyer
COMPLETION DATE: 12/06/95 TIME: 1500	TOTAL DEPTH: 25.5'	RIG TYPE: CME
WATER LEVEL DURING DRILLING: 8' bgs	PVC STICK-UP: 2.19'	METHOD: HSA
SURFACE ELEV.: 7.9' MSL	MP ELEV.: 10.09' TOC PVC	LOGGED BY: A. Como

WELL CONSTRUCTION



DEPTH (in feet)	U.S.C.S.	SOIL DESCRIPTION	TYPE	BLOWS /ft	%RECOVERY	PID (ppm)
0		FILL: Grey gravel; pieces of concrete; sawdust at 3-5'				
5	SP	SAND: Fine grained; poorly graded; black with some reddish brown grains; dry	SS	12 15 18		
			SS	12 15 17		
		8' - becomes moist to wet				
10	SP SW	SAND: Fine to medium grained; poorly to well graded; black; wet	SS	12 14 17		
	ML	CLAYEY SILT: Grey to brown; no to low plasticity; organic material; dry to moist	SS	4 7 7		
15						

REMARKS: SS = Split Spoon

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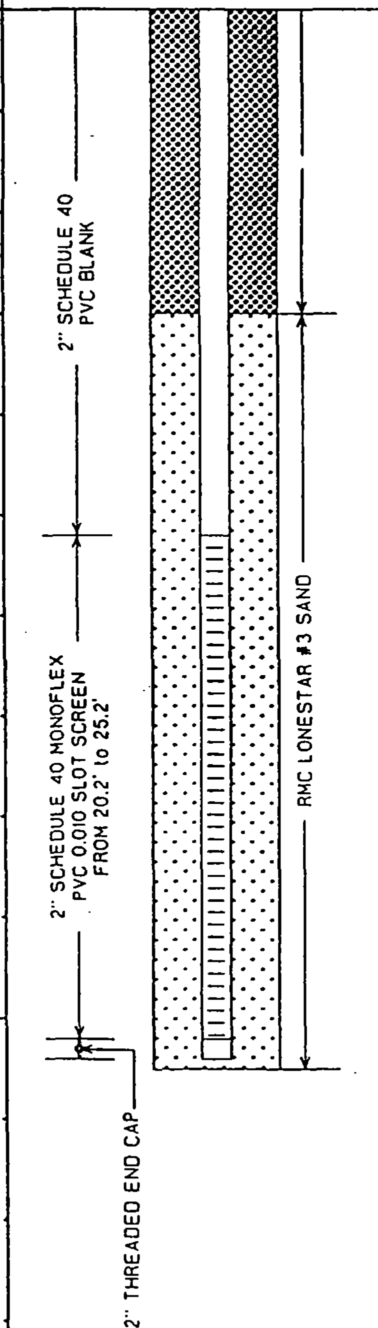
BORING/WELL INSTALLATION LOG
Monitoring Well MW-3D

WELL CONSTRUCTION



SOIL DESCRIPTION / SAMPLE DATA

DEPTH (in feet)	U.S.C.S.	SOIL DESCRIPTION	TYPE	BLOWS /ft	%RECOVERY	PID (ppm)
15	ML		SS	7 8 8		
		17.5' – becomes less clayey	SS	7 8 8		
	SP	SAND: Fine grained; poorly graded; black with some reddish brown grains; moist to wet				
20	SP SM	SAND WITH SILT: Fine grained sand with some interbedded silt; poorly graded; black with some reddish brown grains; wet	SS	13 15 16		
	SW	SAND: Fine to medium grained with some coarse sand; well graded; black with some reddish brown grains; few pieces of fine gravel; wet	SS	12 15 17		
25		Total Depth = 25.5 ft.				
30						

REMARKS: SS = Split Spoon

BORING/WELL INSTALLATION LOG

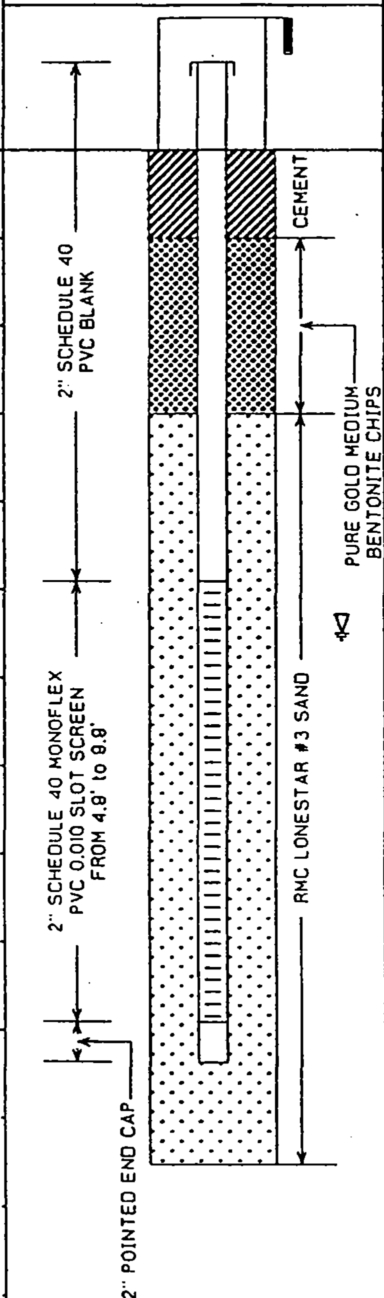
Monitoring Well MW-4S

RETEC

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA East of former tank farm #1		DRILLING CO.: Cascade Drilling
START DATE: 12/06/95 TIME: 1250	BORING ID: 8"	DRILLER: S. Krueyer
COMPLETION DATE: 12/06/95 TIME: 1305	TOTAL DEPTH: 11.5'	RIG TYPE: CME
WATER LEVEL DURING DRILLING: 5.5' bgs	PVC STICK-UP: 2.52'	METHOD: HSA
SURFACE ELEV.: 6.9' MSL	MP ELEV.: 9.42' TOC PVC	LOGGED BY: A. Como

WELL CONSTRUCTION



DEPTH (in feet)	U.S.C.S.	SOIL DESCRIPTION	TYPE	BLOWS /ft
0		FILL: Grey gravel; pieces of concrete		
5	SP	SAND: Fine grained; poorly graded; thin grey silt layer at 6'; black with some reddish brown grains; moist to wet at 5.5'	SS	12 15 18
	SP SW	SAND: Fine to medium grained; poorly to well graded; black with some reddish brown grains; wet	SS	10 12 15
10			SS	12 12 15
	ML	SILT: Slightly clayey; brown to grey; no to low plasticity; organic material; dry to moist		
		Total Depth = 11.5 ft.		
15				

SAMPLE DATA columns: TYPE, DEPTH, BLOWS /ft, %RECOVERY, PID (ppm)

REMARKS: SS = Split Spoon
∎ = Analytical Sample

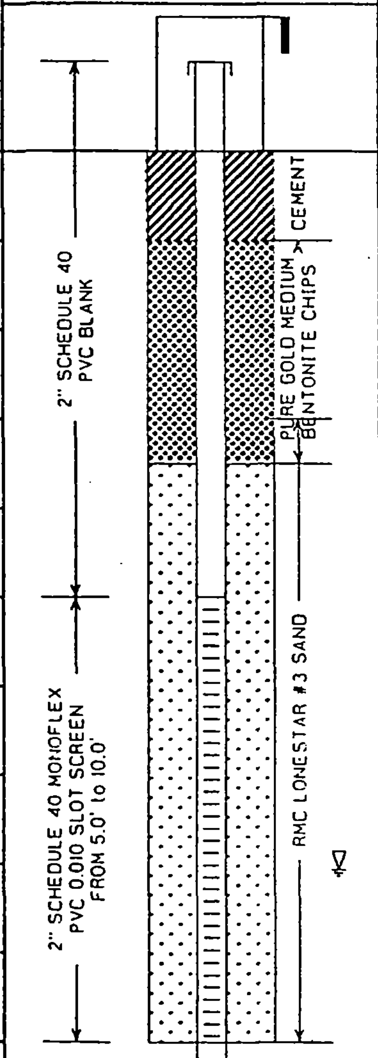
RETEC

BORING/WELL INSTALLATION LOG
Monitoring Well MW-5S

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA East of former tank farm #1		DRILLING CO.: Cascade Drilling
START DATE: 04/10/96 TIME: 0930	BORING ID: 8"	DRILLER: Brent
COMPLETION DATE: 04/10/96 TIME: 1000	TOTAL DEPTH: 10.0'	RIG TYPE: CME 55
WATER LEVEL DURING DRILLING: 8.07' bgs	PVC STICK-UP: '	METHOD: HSA
SURFACE ELEV.: ' NSL	MP ELEV.: ' TOC PVC	LOGGED BY: G. Sega

WELL CONSTRUCTION



DEPTH (in feet)	U.S.C.S.	SOIL DESCRIPTION	TYPE	DEPTH	BLOWS/ft	%RECOVERY	PID (ppm)
0		FILL: Grey gravel; pieces of concrete; dry					
5	GW	SANDY GRAVEL: With roots and grass; tan to brown; dry	SS			50	
	SP	SAND: Medium grained; poorly sorted; dark brown with some reddish brown grains; dry to moist					
		7.5' - becomes wet Total Depth = 10.0 ft.	SS			100	
10							
15							

REMARKS: SS = Split Spoon
▮ = Analytical Sample

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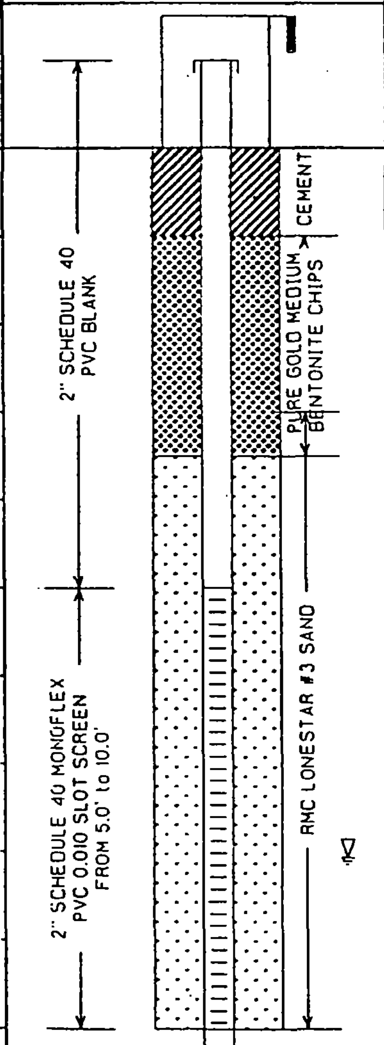
BORING/WELL INSTALLATION LOG
Monitoring Well MW-6S

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA East of former tank farm #1		DRILLING CO.: Cascade Drilling
START DATE: 04/10/96 TIME: 0830	BORING ID: 8"	DRILLER: Brent
COMPLETION DATE: 04/10/96 TIME: 0900	TOTAL DEPTH: 10.0'	RIG TYPE: CME 55
WATER LEVEL DURING DRILLING: 8.07' bgs	PVC STICK-UP: '	METHOD: HSA
SURFACE ELEV.: ' MSL	MP ELEV.: ' TOC PVC	LOGGED BY: G. Sega

WELL CONSTRUCTION



DEPTH (in feet)	U.S.C.S.	SOIL DESCRIPTION	TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)
0		FILL: Grey gravel; pieces of concrete; dry					
5	GW	SANDY GRAVEL: With roots and grass; tan to brown; dry	SS			60	
	SP	SAND: Medium grained; poorly sorted; dark brown with some reddish brown grains; dry to moist					
		7.5' - becomes wet Total Depth = 10.0 ft.	SS			100	
10							
15							

REMARKS: SS = Split Spoon
∎ = Analytical Sample

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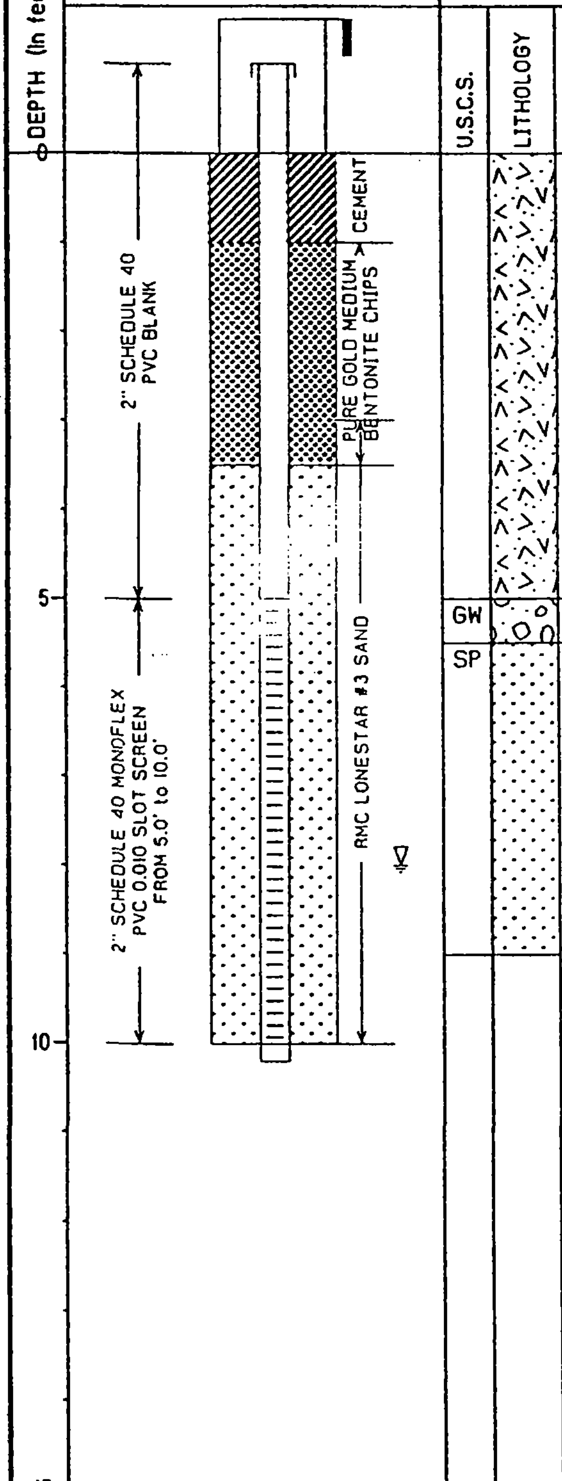
RETEC

BORING/WELL INSTALLATION LOG
Monitoring Well MW-7S

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA East of former tank farm #1		DRILLING CO.: Cascade Drilling
START DATE: 04/10/96 TIME: 0900	BORING ID: 8"	DRILLER: Brent
COMPLETION DATE: 04/10/96 TIME: 0930	TOTAL DEPTH: 10.0'	RIG TYPE: CME 55
WATER LEVEL DURING DRILLING: 8.0' bgs	PVC STICK-UP: '	METHOD: HSA
SURFACE ELEV.: ' MSL	MP ELEV.: ' TOC PVC	LOGGED BY: G. Sega

WELL CONSTRUCTION



U.S.C.S.	SOIL DESCRIPTION	TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)
	FILL: Grey gravel; pieces of concrete; dry					
GW	SANDY GRAVEL: With roots and grass; tan to brown; dry	SS			60	
SP	SAND: Medium grained; poorly sorted; dark brown with some reddish brown grains; dry to moist					
	7.5' - becomes wet Total Depth = 10.0 ft.	SS			100	

REMARKS: SS = Split Spoon
▮ = Analytical Sample

REMEDIATION TECHNOLOGIES, INC.
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RETEC

TEST PIT LOG
TP-1

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA Former tank farm #2		CONTRACTOR: Lone Star (on-site)
START DATE: 11/30/95 TIME: 1150	TEST PIT ID:	OPERATOR:
COMPLETION DATE: 11/30/95 TIME: 1250	TEST PIT DEPTH: 7'	RIG TYPE: Komatsu PL60
WATER LEVEL DURING DRILLING: '	SURFACE ELEV.: ' (MSL)	METHOD:
DATE MEASURED: 11/30/95	M. P. ELEVATION:	LOGGED BY: A. Como

DEPTH (in feet)	SAMPLE DATA: TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION
0								FILL: Gravel; large pieces of concrete
		■				SP		SAND: Fine grained; poorly graded; dark brown to black; dry
5								
						SW		SAND: Fine to medium grained; well graded; black; moist with water seepage at 7'
								Test pit completed at 7 ft.
10								

REMARKS: ■ Analytical sample
Groundwater depth - 7'

RETEC

TEST PIT LOG
TP-2

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA Former tank farm #1		CONTRACTOR: Lone Star (on-site)
START DATE: 11/30/95 TIME: 1320	TEST PIT ID:	OPERATOR:
COMPLETION DATE: 11/30/95 TIME: 1425	TEST PIT DEPTH: 7'	RIG TYPE: Komatsu PL60
WATER LEVEL DURING DRILLING: '	SURFACE ELEV.: ' (MSL)	METHOD:
DATE MEASURED: 11/30/95	M. P. ELEVATION:	LOGGED BY: A. Como

DEPTH (in feet)	SAMPLE DATA: TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION
0								FILL: Gravel; concrete; water seepage through gravels at 1'
						SP		SAND: Fine grained; poorly graded; black; dry
		■				ML		SILT: Some fine sand; dark grey; dry to moist
5		■				SP		SAND: Fine to medium grained; poorly graded; black with some reddish brown grains; moist
						SW		SAND: Fine to medium grained; well graded; black with some reddish brown grains; moist to wet; water at 6.5'
								Test pit completed at 7 ft.
10								

REMARKS: ■ Analytical sample
Groundwater depth - 6.5'

REMEDIATION TECHNOLOGIES, INC.
OFFICES NATIONWIDE

RETEC

TEST PIT LOG
TP-3

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA East of former tank farm #1		CONTRACTOR: Lone Star (on-site)
START DATE: 11/30/95 TIME: 0845	TEST PIT ID:	OPERATOR:
COMPLETION DATE: 11/30/95 TIME: 0935	TEST PIT DEPTH: 7'	RIG TYPE: Komatsu PL60
WATER LEVEL DURING DRILLING: '	SURFACE ELEV.: ' (MSL)	METHOD:
DATE MEASURED: 11/30/95	M. P. ELEVATION:	LOGGED BY: A. Como

DEPTH (in feet)	SAMPLE DATA: TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)	SOIL DESCRIPTION: U.S.C.S.	LITHOLOGY	
0								FILL: Gravel; dry to moist
		■				SP		SAND: Fine grained with some gravel; poorly graded; brown to black; dry to moist
5		■				SM		SILTY SAND: Fine grained interbeds; grey; moist; thin brownish wet zone at 5'
						SP		SAND: Fine grained; poorly graded; brown to black; moist to wet
								Test pit completed at 7 ft.
10								

REMARKS: ■ Analytical sample
Groundwater depth - 5'

RETEC

TEST PIT LOG
TP-4

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA Former phenate process area		CONTRACTOR: Lone Star (on-site)
START DATE: 12/1/95 TIME: 1245	TEST PIT ID:	OPERATOR:
COMPLETION DATE: 12/1/95 TIME: 1305	TEST PIT DEPTH: 4'	RIG TYPE: Komatsu PL80
WATER LEVEL DURING DRILLING: '	SURFACE ELEV.: ' (MSL)	METHOD:
DATE MEASURED: 12/1/95	M. P. ELEVATION:	LOGGED BY: A. Como

DEPTH (in feet)	SAMPLE DATA: TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)	SOIL DESCRIPTION: U.S.C.S.	LITHOLOGY	
0		■						TOPSOIL: Fine to medium sand with silt; dark brown to black; dry
						SP		SAND: Fine grained; poorly graded; dark brown to black; dry; water seepage at 4'
								Test pit completed at 4 ft.
5								
10								

REMARKS: ■ Analytical sample
Groundwater depth - 4'

RETEC

TEST PIT LOG
TP-5

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA Former phenate process area		CONTRACTOR: Lone Star (on-site)
START DATE: 12/1/95 TIME: 1310	TEST PIT ID:	OPERATOR:
COMPLETION DATE: 12/1/95 TIME: 1325	TEST PIT DEPTH: 4'	RIG TYPE: Komatsu PL60
WATER LEVEL DURING DRILLING: '	SURFACE ELEV.: ' (MSL)	METHOD:
DATE MEASURED: 12/1/95	M. P. ELEVATION:	LOGGED BY: A. Como

DEPTH (in feet)	SAMPLE DATA: TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION
0								TOPSOIL: Fine to medium sand with silt and some gravel; organic material; few large pieces of concrete; dry
		■				SP		SAND: Fine grained; poorly graded; dark brown to black; moist; water encountered at 4'
								Test pit completed at 4 ft.
5								
10								

REMARKS: ■ Analytical sample
Groundwater depth - 4'

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Suite 207
Seattle, WA 98134
(206) 624-9349

TEST PIT LOG
TP-6

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA Former Northern ditch area		CONTRACTOR: Lone Star (on-site)
START DATE: 12/1/95 TIME: 1335	TEST PIT ID:	OPERATOR:
COMPLETION DATE: 12/1/95 TIME: 1400	TEST PIT DEPTH: 4'	RIG TYPE: Komatsu PL60
WATER LEVEL DURING DRILLING: '	SURFACE ELEV.: ' (MSL)	METHOD:
DATE MEASURED: 12/1/95	M. P. ELEVATION:	LOGGED BY: A. Como

DEPTH (in feet)	SAMPLE DATA: TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)	SOIL DESCRIPTION: U.S.C.S.	LITHOLOGY	
0		■						TOPSOIL: Fine to medium sand with silt and some gravel; organic material; dark brown; dry
						SP		SAND: Fine grained black material (carbon?); thin grey fine sand/silt at 2.8-3'; dry to moist
						SW		SAND: Fine to coarse grained with some fine gravel; well graded; dark brown; moist to wet; water encountered at 4'
								Test pit completed at 4 ft.
5								
10								

REMARKS: Black material from 1'-3' appears to outline former ditch in Northern section of site
■ Analytical sample
Groundwater depth - 4

RETEC

TEST PIT LOG
TP-7

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA Former septic tank		CONTRACTOR: Lone Star (on-site)
START DATE: 12/1/95 TIME: 1410	TEST PIT ID:	OPERATOR:
COMPLETION DATE: 12/1/95 TIME: 1430	TEST PIT DEPTH: 3'	RIG TYPE: Komatsu PL60
WATER LEVEL DURING DRILLING: '	SURFACE ELEV.: ' (MSL)	METHOD:
DATE MEASURED: 12/1/95	M. P. ELEVATION:	LOGGED BY: A. Como

DEPTH (in feet)	SAMPLE DATA: TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION
0								TOPSOIL: Silt with some sand and small gravel; organic material; brown to dark brown; dry; becomes moist at 2'
		■				SW		SAND: Fine to medium grained; well graded; black; moist to wet; water encountered at 3'
								Test pit completed at 3 ft.
5								
10								

REMARKS: ■ Analytical sample
Groundwater depth - 3'

RETEC

TEST PIT LOG
TP-8

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA Northeast corner of first pilot plant		CONTRACTOR: Lone Star (on-site)
START DATE: 11/30/95 TIME: 0940	TEST PIT ID:	OPERATOR:
COMPLETION DATE: 11/30/95 TIME: 1015	TEST PIT DEPTH: 6'	RIG TYPE: Komatsu PL60
WATER LEVEL DURING DRILLING: '	SURFACE ELEV.: ' (MSL)	METHOD:
DATE MEASURED: 11/30/95	M. P. ELEVATION:	LOGGED BY: A. Como

DEPTH (in feet)	SAMPLE DATA: TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION
0								FILL: Gravel; concrete; dry to moist
		■				SP		SAND: Fine grained with some gravel; poorly graded; black; moist; water seepage at 2'
						SP		SAND: Fine grained; poorly graded; grey to brown with some iron staining; moist
5						SW		SAND: Fine to medium grained; well graded; grey to black with some reddish brown grains; moist; thin grey fine sand/silt zone at 5.5'; water encountered at 6'
								Test pit completed at 6 ft.
10								

REMARKS: ■ Analytical sample
Groundwater depth - 6'

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TEST PIT LOG
TP-9

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA Southwest corner of first PCP pilot plant		CONTRACTOR: Lone Star (on-site)
START DATE: 11/30/95 TIME: 1020	TEST PIT ID:	OPERATOR:
COMPLETION DATE: 11/30/95 TIME: 1100	TEST PIT DEPTH: 7'	RIG TYPE: Komatsu PL60
WATER LEVEL DURING DRILLING: 6'	SURFACE ELEV.: ' (MSL)	METHOD:
DATE MEASURED: 11/30/95	M. P. ELEVATION:	LOGGED BY: A. Como

DEPTH (in feet)	SAMPLE DATA: TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION
0								FILL: Gravel; pieces of brick; dry to moist
		■				SP		SAND: Fine grained; poorly graded; black carbon material; water seepage at 2.5'
5		■				SP		SAND: Fine grained; poorly graded; grey to brown; fine grey sand/silt zone at 5.5' (sampled)
						SW		SAND: Fine to medium grained; well graded; grey to black with some reddish brown grains; moist to wet; water encountered at 6.5'
								Test pit completed at 7 ft.
10								

REMARKS: ■ Analytical sample
Groundwater depth - 6'

REMEDIATION TECHNOLOGIES, INC.
OFFICES NATIONWIDE

RETEC

TEST PIT LOG
TP-10

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA North end of former impoundment area		CONTRACTOR: Lone Star (on-site)
START DATE: 11/30/95 TIME: 1105	TEST PIT ID:	OPERATOR:
COMPLETION DATE: 11/30/95 TIME: 1140	TEST PIT DEPTH: 7'	RIG TYPE: Komatsu PL60
WATER LEVEL DURING DRILLING: 7'	SURFACE ELEV.: ' (MSL)	METHOD:
DATE MEASURED: 11/30/95	M. P. ELEVATION:	LOGGED BY: A. Como

DEPTH (in feet)	SAMPLE DATA: TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION
0								FILL: Gravel; pieces of concrete
		■				SP		SAND: Fine grained; poorly graded; some gravel and degraded concrete; dark grey to black; dry to moist 4.5' - dark reddish brown rubber-like material; 0.2 to 0.5' thick
5		■				SW		SAND: Fine to medium grained; well graded; grey to black with some reddish brown grains; moist to wet; water encountered at 7'
								Test pit completed at 7 ft.
10								

REMARKS: ■ Analytical sample
Groundwater depth - 7'

RETEC

TEST PIT LOG
TP-11

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA Former impoundment area		CONTRACTOR: Lone Star (on-site)
START DATE: 11/30/95 TIME: 1430	TEST PIT ID:	OPERATOR:
COMPLETION DATE: 11/30/95 TIME: 1455	TEST PIT DEPTH: 7'	RIG TYPE: Komatsu PL60
WATER LEVEL DURING DRILLING: 7'	SURFACE ELEV.: ' (MSL)	METHOD:
DATE MEASURED: 11/30/95	M. P. ELEVATION:	LOGGED BY: A. Como

DEPTH (in feet)	SAMPLE DATA: TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)	SOIL DESCRIPTION: U.S.C.S.	LITHOLOGY	
0								FILL: Gravel; pieces of concrete; some water seepage from gravel
		■				SP		SAND: Fine grained; poorly graded; dark brown to black with some discontinuous reddish brown sawdust; dry
5		■				SW		SAND: Fine to medium grained; well graded; black with some reddish brown grains; moist to wet; water encountered at 7'
						▼		Test pit completed at 7 ft.
10								

REMARKS: ■ Analytical sample
Groundwater depth - 7'

RETEC

TEST PIT LOG
TP-12

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA Former impoundment area		CONTRACTOR: Lone Star (on-site)
START DATE: 11/30/95 TIME: 1500	TEST PIT ID:	OPERATOR:
COMPLETION DATE: 11/30/95 TIME: 1525	TEST PIT DEPTH: 7'	RIG TYPE: Komatsu PL60
WATER LEVEL DURING DRILLING: 7'	SURFACE ELEV.: ' (MSL)	METHOD:
DATE MEASURED: 11/30/95	M. P. ELEVATION:	LOGGED BY: A. Como

DEPTH (in feet)	SAMPLE DATA: TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION
0								FILL: Gravel
						SP		SAND: Fine grained; poorly graded; some silt; dark grey to black with some reddish brown sawdust at 3-4'; dry
5								
		■				SW		SAND: Fine to medium grained; well graded; black with some reddish brown grains; moist to wet; water encountered at 7'
								Test pit completed at 7 ft.
10								

REMARKS: ■ Analytical sample
Groundwater depth - 7'

REMEDIATION TECHNOLOGIES, INC.
OFFICES NATIONWIDE

RETEC

TEST PIT LOG
TP-13

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA Former Southern ditch		CONTRACTOR: Lone Star (on-site)
START DATE: 11/30/95 TIME: 1530	TEST PIT ID:	OPERATOR:
COMPLETION DATE: 11/30/95 TIME: 1600	TEST PIT DEPTH: 7'	RIG TYPE: Komatsu PL60
WATER LEVEL DURING DRILLING: 7'	SURFACE ELEV.: ' (MSL)	METHOD:
DATE MEASURED: 11/30/95	M. P. ELEVATION:	LOGGED BY: A. Como

DEPTH (in feet)	SAMPLE DATA: TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION
0								FILL: Gravel; pieces of concrete
								FILL: Fine grained sand; some small gravel; poorly graded; dark grey to black with some reddish brown sawdust; dry
5						SP		SAND: Fine grained; poorly graded; black; dry to moist
		■				SW		SAND: Fine to medium grained; well graded; black; moist; water encountered at 7'
								Test pit completed at 7 ft.
10								

REMARKS: ■ Analytical sample
Groundwater depth - 7'

REMEDIATION TECHNOLOGIES, INC.
OFFICES NATIONWIDE

RETEC

TEST PIT LOG
TP-14

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA Former Southern ditch		CONTRACTOR: Lone Star (on-site)
START DATE: 12/1/95 TIME: 0835	TEST PIT ID:	OPERATOR:
COMPLETION DATE: 12/1/95 TIME: 1135	TEST PIT DEPTH: 8'	RIG TYPE: Komatsu PL60
WATER LEVEL DURING DRILLING: 7.5'	SURFACE ELEV.: ' (MSL)	METHOD:
DATE MEASURED: 12/1/95	N. P. ELEVATION:	LOGGED BY: A. Como

DEPTH (in feet)	SAMPLE DATA: TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION
0								FILL: Gravel; large pieces of concrete
		■						FILL: Fine sandy material (carbon?); black; dry
5						SP		SAND: Fine grained; poorly graded; thin grey sand/silt layer at 3.8'; dark grey to black; dry; becomes moist at 6'
						SW		SAND: Fine to medium grained; well graded; dark grey to black with some reddish brown grains; moist to wet; water encountered at 7.5'
								Test pit completed at 8 ft.
10								

REMARKS: ■ Analytical sample
Groundwater depth - 7.5'

REMEDIATION TECHNOLOGIES, INC.
OFFICES NATIONWIDE

RETEC

BORING LOG
GP-1

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA Northern former tank farm #1		DRILLING CO.: NCEC
START DATE: 12/04/95 TIME: 1220	BORING ID: 2"	DRILLER: Jerry Eide
COMPLETION DATE: 12/04/95 TIME: 1315	BORING DEPTH: 12'	RIG TYPE:
WATER LEVEL DURING DRILLING: 4'	SURFACE ELEV.: ' (MSL)	METHOD: Geoprobe
DATE MEASURED: 12/04/95	M. P. ELEVATION:	LOGGED BY: A. Como

DEPTH (in feet)	SAMPLE DATA: TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION
0								CONCRETE:
								FILL: Gravel; sand; grey to brown; moist
	CS					SP ∇		SAND: Fine grained; poorly graded; black; moist; becomes wet at 4'
5						SW		SAND: Fine to medium grained; well graded; black; moist to wet
	CS							
10						SM		SILTY SAND: Fine grained; poorly graded; wet
						ML		SILT: With some sand, clay, and organic material (roots); very dark grey; medium plasticity
								Total Depth = 12 ft.
15								

REMARKS: ■ Analytical sample
CS = 2" x 4' Core sample
Groundwater depth - 4'

RETEC

BORING LOG
GP-2

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA Western end of second pilot plant		DRILLING CO.: WCEC
START DATE: 12/04/95 TIME: 0900	BORING ID: 2"	DRILLER: Jerry Eide
COMPLETION DATE: 12/05/95 TIME: 0920	BORING DEPTH: 14'	RIG TYPE:
WATER LEVEL DURING DRILLING: 4'	SURFACE ELEV.: ' (MSL)	METHOD: Geoprobe
DATE MEASURED: 12/04/95	M. P. ELEVATION:	LOGGED BY: A. Como

DEPTH (in feet)	TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION
0								CONCRETE:
								FILL: Gravel; sand; brown to grey
	CS					SW		SAND: Fine to medium grained; well graded; black with some reddish brown grains; dry; becomes wet at 4'
5								
	CS							
10								
	CS					SM		SANDY SILT: Gray; wet
						ML		CLAYEY SILT: With some fine sand; organic material (roots); brown to grey; moist
								Total Depth = 14 ft.
15								

REMARKS:
■ Analytical sample
CS = 2" x 4' Core sample
Groundwater depth - 4'

RETEC

BORING LOG

GP-3

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA Northern end of second pilot plant		DRILLING CO.: WCEC
START DATE: 12/04/95 TIME: 1115	BORING ID: 2"	DRILLER: Jerry Eide
COMPLETION DATE: 12/04/95 TIME: 1215	BORING DEPTH: 16'	RIG TYPE:
WATER LEVEL DURING DRILLING: 4'	SURFACE ELEV.: ' (MSL)	METHOD: Geoprobe
DATE MEASURED: 12/04/95	M. P. ELEVATION:	LOGGED BY: A. Como

DEPTH (in feet)	SAMPLE DATA: TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION
0								CONCRETE:
								FILL: Gravel; sand; brown to grey
	CS					SW		SAND: Fine to medium grained; well graded; grey to black with some brown silt; dry to moist; becomes wet at 4'
5								
	CS							
10								
	CS					SM		SILTY SAND: Fine grained; organic material (roots etc.); wet
						SW		SAND: Fine to medium grained; well graded; black; wet
15						ML		SANDY SILT: With some clay and organic material (roots, wood); very dark grey; medium plasticity; moist to wet
								Total Depth = 16 ft.
20								

REMARKS: ■ Analytical sample
CS = 2" x 4' Core sample
Groundwater depth - 4'

REMEDIATION TECHNOLOGIES, INC.
OFFICES NATIONWIDE

RETEC

BORING LOG
GP-4

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA Eastern end of second pilot plant		DRILLING CO.: NCEC
START DATE: 12/04/95 TIME: 1000	BORING ID: 2"	DRILLER: Jerry Eide
COMPLETION DATE: 12/04/95 TIME: 1100	BORING DEPTH: 16'	RIG TYPE:
WATER LEVEL DURING DRILLING: 4'	SURFACE ELEV.: ' (MSL)	METHOD: Geoprobe
DATE MEASURED: 12/04/95	M. P. ELEVATION:	LOGGED BY: A. Como

DEPTH (in feet)	SAMPLE DATA: TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION
0								CONCRETE:
								FILL: Gravel; sand; grey to brown
		■				ML		SILT: With some clay and gravel; greenish grey; dry
	CS					SW		SAND: Fine to medium grained; well graded; black with some reddish brown grains; dry to moist; becomes wet at 4'
5								
	CS							
10								
						SM		SILTY SAND: Black; wet
	CS					SP		SAND: Fine grained; poorly graded; black
15						ML		SANDY SILT With some clay and organic material (roots etc.); very dark grey; wet
								Total Depth = 16 ft.
20								

REMARKS: Hole backfilled with fine granular bentonite
■ Analytical sample
CS = 2" x 4' Core sample
Groundwater depth - 4'

REMEDIATION TECHNOLOGIES, INC.
OFFICES NATIONWIDE

RETEC

BORING LOG
GP-5

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA Southeast corner of second pilot plant		DRILLING CO.: WCEC
START DATE: 12/04/95 TIME: 1430	BORING ID: 2"	DRILLER: Jerry Eide
COMPLETION DATE: 12/04/95 TIME: 1505	BORING DEPTH: 12'	RIG TYPE:
WATER LEVEL DURING DRILLING: 4'	SURFACE ELEV.: ' (MSL)	METHOD: Geoprobe
DATE MEASURED: 12/04/95	M. P. ELEVATION:	LOGGED BY: A. Como

DEPTH (in feet)	SAMPLE DATA: TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION
0								TOPSOIL: Grass; organic material
								FILL: Fine to medium sand; gravel; dry
						SP		SAND: Fine to medium grained; poorly graded; dark brown to black with some reddish brown grains; some small gravel; thin sandy silt at 2.5'; dry
	CS					SW		SAND: Fine to medium grained; well graded; dark brown with some reddish brown grains; wet
5								
	CS					SP		SAND: Fine to medium grained; poorly graded; black with some reddish brown grains; wet
10						SM		SILTY SAND: Fine grained; black with some reddish brown grains; wet
								Total Depth = 12 ft.
15								

REMARKS: ■ Analytical sample
CS = 2" x 4' Core sample
Groundwater depth ~ 4'

RETEC

BORING LOG
GP-6

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA Former southern ditch in North area		DRILLING CO.: WCEC
START DATE: 12/04/95 TIME: 1335	BORING ID: 2"	DRILLER: Jerry Elde
COMPLETION DATE: 12/04/95 TIME: 1420	BORING DEPTH: 12'	RIG TYPE:
WATER LEVEL DURING DRILLING: 4'	SURFACE ELEV.: ' (MSL)	METHOD: Geoprobe
DATE MEASURED: 12/04/95	M. P. ELEVATION:	LOGGED BY: A. Como

DEPTH (in feet)	SAMPLE DATA: TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION
0								TOPSOIL: Grass; organic material
								FILL: Fine to medium sand; gravel; grey to brown; dry
	CS					SW		SAND: Fine to medium grained; well graded; brown to grey with some reddish brown grains; dry to moist; becomes wet at 4'
5								
	CS							
10								
						SM		SANDY SILT: Some clay and organic material (roots, wood); low to medium plasticity; dry to moist
								Total Depth = 12 ft.
15								

REMARKS: ■ Analytical sample
CS = 2" x 4' Core sample
Groundwater depth - 4'

RETEC

BORING LOG
GP-7

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA In Test Pit TP-11 (former impoundment area)		DRILLING CO.: WCEC
START DATE: 12/04/95 TIME: 1525	BORING ID: 2"	DRILLER: Jerry Eide
COMPLETION DATE: 12/04/95 TIME: 1630	BORING DEPTH: 18'	RIG TYPE:
WATER LEVEL DURING DRILLING: 6'	SURFACE ELEV.: ' (MSL)	METHOD: Geoprobe
DATE MEASURED: 12/04/95	M. P. ELEVATION:	LOGGED BY: A. Como

DEPTH (in feet)	SAMPLE DATA: TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION
0								FILL: Gravel; pieces of concrete; some water seepage from gravel
						SP		SAND: Fine grained; poorly graded; dark brown to black with some discontinuous reddish brown sawdust; dry
5	CS					SW		SAND: Fine to medium grained; well graded; black with some reddish brown grains; wet
10	CS							
	CS							
15						SM		SANDY SILT: Some clay; dark grey; moist
								Total Depth = 16 ft.
20								

REMARKS: GP-7 located in TP-11. 2" diameter auger to 6'. Then start sampling.
First 6' logged from test pit log.
■ Analytical sample
CS = 2" x 4' Core sample
Groundwater depth - 6'

REMEDIATION TECHNOLOGIES, INC.
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RETEC

BORING LOG
GP-8

1011 SW Klickitat Way
Suite 207
Seattle, WA 98134
(206) 624-9349

PROJECT NO: 3-2137-220 Lone Star/Reichhold		CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA In Test Pit TP-1 (former tank farm #2)		DRILLING CO.: HCEC
START DATE: 12/05/95 TIME: 1025	BORING ID: 2"	DRILLER: Jerry Eide
COMPLETION DATE: 12/05/95 TIME: 1100	BORING DEPTH: 10'	RIG TYPE:
WATER LEVEL DURING DRILLING: 7'	SURFACE ELEV.: ' (MSL)	METHOD: Geoprobe
DATE MEASURED: 12/05/95	M. P. ELEVATION:	LOGGED BY: A. Como

DEPTH (in feet)	SAMPLE DATA: TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION
0								FILL: Gravel; large pieces of concrete
5						SP		SAND: Fine grained; poorly graded; dark brown to black; dry
						SW ▽		SAND: Fine to medium grained; well graded; black; moist Driller noted change in resistance at 10'; feels like silt contact encountered elsewhere
10								Total Depth = 10 ft.
15								

REMARKS: GP-8 located in TP-1. Boring logged from test pit log.
Groundwater depth - 7'

RETEC

BORING LOG
GP-9

1011 SW Klickitat
Suite
Seattle, WA 9
(206) 624-9

PROJECT NO: 3-2137-220 Lone Star/Reichhold	CLIENT: Lone Star/Reichhold
LOCATION: Seattle, WA In Test Pit TP-13 (former Southern ditch)	DRILLING CO.: WCEC
START DATE: 12/05/95 TIME: 0935 — BORING ID: 2"	DRILLER: Jerry Eide
COMPLETION DATE: 12/05/95 TIME: 1020 — BORING DEPTH: 12'	RIG TYPE:
WATER LEVEL DURING DRILLING: 7' — SURFACE ELEV.: ' (MSL)	METHOD: Geoprobe
DATE MEASURED: 12/05/95 — M. P. ELEVATION:	LOGGED BY: A. Como

DEPTH (in feet)	SAMPLE DATA: TYPE	DEPTH	BLOWS /ft	%RECOVERY	PID (ppm)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION
0								FILL: Gravel; pieces of concrete;
						SP		SAND: Fine grained; some small gravel; poorly graded; dark grey to black w some discontinuous reddish sawdust; dry
5								
								SAND: Fine to medium grained; well graded; black; moist
	CS							
10								
						ML		CLAYEY SILT: Some organic material (roots); brown to grey; moist
								Total Depth = 12 ft.
15								

REMARKS: GP-8 located in TP-13. 2" diameter auger to 8', then start sampling.
First 8' logged from test pit log.
■ Analytical sample
CS = 2" x 4' Core sample
Groundwater depth - 7'

REMEDIATION TECHNOLOGIES, INC.
OFFICES NATIONWIDE

Way
207
3134
349

ILLEGIBLE ORIGINAL

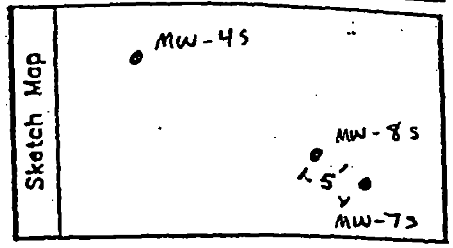
th

ILLEGIBLE ORIGINAL

FLUOR DANIEL GTI

Well No.: MW-8s

Page 1 of 1



Project: Reichold / Lone Star
Location: 5900 W Marginal Way S, Seattle WA
Project No.: 020600355 Date: 8/4/97
Elevation: Well Depth: 11'
Expl. Depth: 11' Hole Dia.: 8"
Casing: Dia.: 2" Length: 3' Type: SCH 40 PVC
Screen: Dia.: 2" Length: 8' Slot Size: 0.020"
Drilling Co.: Cascade Driller: Brian Gose Logged by: SAH
Drilling Meth.: HSA CME-75 Sampling Meth. split spoon.
Notes:
Key: Concrete Bentonite Native Backfill Sand/Gravel Pack Well Screen

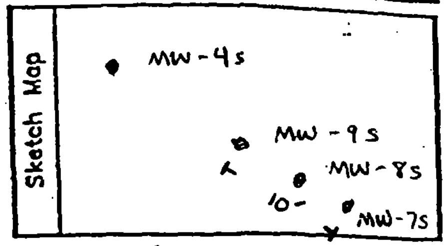
Depth (feet)	Well Construction	Sample No.	% Rec.	Blows/ Density	PID Rdg. (ppm)	Depth (feet)	Soils/Lithology
0		x x	X			GM	Start drlg @ 10:50. Gravel surface Gravel
		x x	X			SM	No sample due to rock
		26 50/6	80				Lt brown - lt gray SAND, some silt, trace gravel (dry, no odor)
		25 50/6	100				Dk brown to black fine homogenous SAND trace red grains. (dry, no odor)
5		46 50/6	100				
		35 33 29	100				
		17 20 20	100			SP	Encountered water Increasing red grains
		17 20 25	100				
10		11 19 21	100			ML	Brown SILT and clay, high organic content (damp, no odor)

End of borehole @ 11:20 Install MW screen 3-11' bg. Sand 2-11' bg. Chip 1-2' bg.

FLUOR DANIEL GTI

Well No.: MW-9s

Page 1 of 1



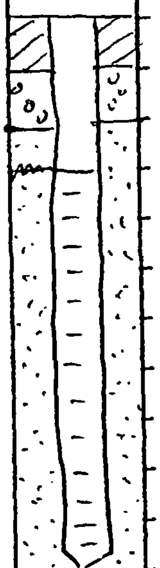
Project:	Reichold / Lone Star		
Location:	5900. W. Marginal Way S		
Project No.:	020600355	Date:	8/4/97
Elevation:		Well Depth:	11'
Expl. Depth:	11'	Hole Dia.:	8"
Casing: Dia.:	2"	Length:	3'
Screen: Dia.:	2"	Length:	8'
Drilling Co.:	Cascade	Driller:	Brian Gose
Drilling Meth.:	HSA CME-75	Sampling Meth.	split spoon
Notes:			

Type: SCH 40 PVC

Slot Size: 0.020"

Logged by: SAH

Key: Concrete, Bentonite, Native Backfill, Sand/Gravel Pack, Well Screen

Depth (feet)	Well Construction	Sample No.	% Rec.	Blows/ Density	PID Rdg. (ppm)	Depth (feet)	Soils/Lithology
							NO SAMPLING. ESTIMATED LITHOLOGIES BASED ON MW-8s
0						SM	BROWN SILTY-SAND AND GRAVEL
5						SP	BLACK SAND
10						ML	CLAYEY-SILT

CONFIDENTIAL

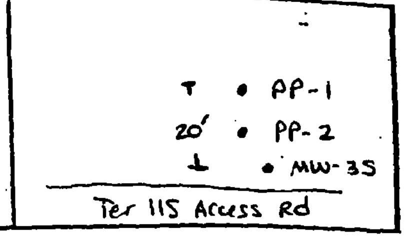
FLUOR DANIEL GTI

Well No.: PP-1

Page 1 of 1

Project: Reichold / Lone Star
Location: 5900. W Meridian Way S
Project No.: 020600355 Date: 8/4/97
Elevation: Well Depth: 11'
Expl. Depth: 11' Hole Dia.: 8"
Casing: Dia.: 2" Length: 6'
Screen: Dia.: 2" Length: 5'
Drilling Co.: Cascade Driller: Brian Gose
Drilling Meth.: HSA CME-55 Sampling Meth. none
Notes:

Sketch Map



Type: SCH 40 PVC
Slot Size: 0.020"
Logged by: SAH

Key: Concrete, Bentonite, Native Backfill, Sand/Gravel Pack, Well Screen

Depth (feet)	Well Construction	Sample No.	% Rec.	Blows/Density	PID Rdg. (ppm)	Depth (feet)	Soils/Lithology
0						SM	No sampling. Lithologies based on PP-2 SILTY-SAND and gravel
5						SP	Black sand
10							

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[illegible] soil drums
1 decon water drum

FLUOR DANIEL GTI

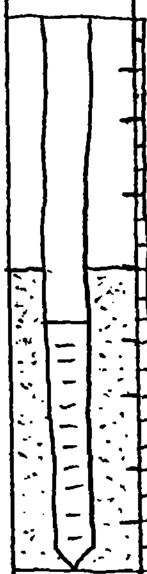
Well No.: PP-2

Page 1 of 1

Project: Reichold / Lone Star
Location: 5900 W. Marginal Way S. Seattle WA
Project No.: 020600355 Date: 8/4/97
Elevation: Well Depth: 11'
Expl. Depth: 11.5' Hole Dia.: 8"
Casing: Dia.: 2" Length: 6' Type: SCH 40 PVC
Screen: Dia.: 2" Length: 5' Slot Size: 0.020"
Drilling Co.: Cascade Driller: Brian ~~Smith~~ Gore Logged by: Steve Hartman
Drilling Meth.: HSA CME-55 Sampling Meth. split spoon
Notes:

Key: Concrete, Bentonite, Native Backfill, Sand/Gravel Pack, Well Screen

Sketch Map: 10' TO PP-2 · TO MW-3S · Terminal 115 access rd



Depth (feet)	Sample No.	% Rec.	Blows/Density	PID Rdg. (ppm)	Depth (feet)	Soils/Lithology
0	X, X, 100/4	X				Start drlg @ 8:35.
	X, 27, 50	10			SM	Gravel surface. Dark brown ~~gravel~~, ~~sand~~, ~~and silt~~ to gray fine-med SAND, and silt, trace gravel
	X, 26, 17	30			ML	Dark brown ~~sand~~ SILT high organic content fibrous habit (moist, no odor)
5	14, 14, 26	100				grades tan, little fine sand
	29, 20, 50/6	100			SP	Black fine homogenous SAND, trace red and white fine grains (dry, no odor)
	27, 28, 30	100				increasing red grains
10	X, X, 11	X				Encounter water @ 910
	19, 25	100				End boring (920). Install MW for push-pull testing. Screen 6-11'. Sand 5-11'.

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FLUOR DANIEL GTI

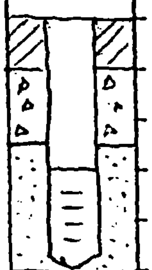
Well No.: INJ-1

Page 1 of 1

Sketch Map
- INJ-1
- SS-1
- SS-2
- MW-35

Ter 115 Access Rd

Project: Lone Star / Reichold
Location: 5900 W. Marginal Way S Seattle WA
Project No.: 020600355 Date: 8/4/97
Elevation: Well Depth: ~~?~~ 5'
Expl. Depth: 5' Hole Dia.: 10"
Casing: Dia.: 4" Length: 3' Type: SCH 40 PVC
Screen: Dia.: 4" Length: 2' Slot Size: 0.020"
Drilling Co.: Cascade Driller: Brian Gose Logged by: SAH
Drilling Meth.: HSA CME-75 Sampling Meth. none
Notes:
Key: Concrete, Bentonite, Native Backfill, Sand/Gravel Pack, Well Screen

Depth (feet)	Well Construction	Sample No.	% Rec.	Blows/ Density	PID Rdg. (ppm)	Depth (feet)	Soils/Lithology
0						SM	No samples. Lithologies based on SS-2. SILTY-SAND and gravel
						SP	Black fine grain SAND
5							

FLUOR DANIEL GTI

Well No.: MW-10

Project: Reichhold

Location: 5900 W. Marginal Way S., Seattle

Project No.: 020600335

Date: 10/13/98

Elevation:

Well Depth: 10 ft.

Expl. Depth: 11.5 ft

Hole Dia.: 8"

Casing: Dia.: 2"

Length: 3 ft.

Screen: Dia.: 2"

Length: 7 ft.

Drilling Co.: Cascade

Driller: Scott Cruger

Drilling Meth.: auger

Sampling Meth. 1.5 ft. sampler w/ 1.0 ft. sample

Notes:

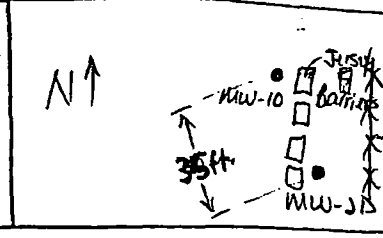
Type:

Slot Size:

Logged by: C. Kilday

Page 1 of 1

Sketch Map



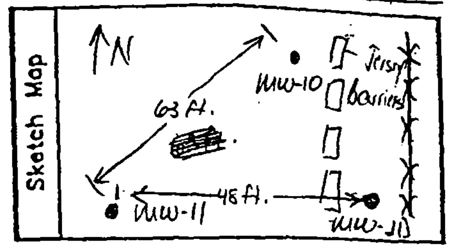
Key: Concrete, Bentonite, Native Backfill, Sand/Gravel Pack, Well Screen

Depth (feet)	Well Construction	Sample No.	% Rec.	Blows/Density	PID Rdg. (ppm)	Depth (feet)	Soils/Lithology
0	Box						
1	Conc.						
2	Bent.						
3	Sand						
4							
5							
6		MW-10 -5.5-6.5	100	32 50/6"		SP	m-c SAND, trace silt gray/black (damp, ~~loose~~ dense, slight odor)
7							
8							
9							
10		MW-10 -10-10.5	100	10 13 13		CL	brown ~~f SAND and~~ SILTY CLAY, trace very f. sand (damp, ~~tight~~ very stiff, no noticeable odor)
							set well bottom @ 10 ft. bg.

FLUOR DANIEL GTI

Well No.: MW-11

Page 1 of 1



Project: Reichhold
Location: 5900 W. Marginal Way S, Seattle
Project No.: 020600335
Date: 10/13/98
Elevation:
Well Depth: 10 ft.
Expl. Depth: 11.5 ft.
Hole Dia.: 8"
Casing: Dia.: 2"
Length: 7 ft.
Type:
Screen: Dia.: 2"
Length: 3 ft.
Slot Size:
Drilling Co.: Cascade
Driller: Scott Kruger
Logged by: C. Kilday
Drilling Meth.: auger
Sampling Meth. 1.5 ft. sampler w/1.0 ft. sample
Notes:

Key: Concrete, Bentonite, Native Backfill, Sand/Gravel Pack, Well Screen

Depth (feet)	Well Construction	Sample No.	% Rec.	Blows/ Density	PID Rdg. (ppm)	Depth (feet)	Soils/Lithology
0	Well Box						
1	Conc.						
2	Bent. / Blank PVC						
3							
4	Slotted					SP	4" gray/black M-C SAND, trace silt (damp, dense, sl. odor)
5		MW-11 ~~5.5-6.5~~ 5.5-6.5	100	33		SM	4" brown SILTY SAND (damp, dense, slight odor)
6				50/6"		SP	4" gray/brown M-C SAND, trace silt (damp, dense, sl. odor)
7							
8							
9						~~OL~~	~~@ ... SILTY CLAY, trace fine sand~~
10		MW-11 -10-10.5	100	9 12 12		~~SM~~ OL	~~brown ... SAND, trace silt ...~~ Brown SILTY CLAY, trace very fine sand (damp, ~~...~~ stiff, no noticeable odor) (roots in 1st 4")
							set well bottom @ 10 ft. bg

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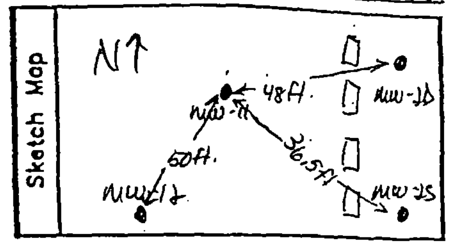
FLUOR DANIEL GTI

Well No.: MW-12

Page 1 of 1



Project: Leichhold
Location: 5900 W. Marginal Way S, Seattle
Project No.: 020600335 Date: 10/13/98
Elevation: Well Depth: 11.5 ft.
Expl. Depth: 11.5 ft. Hole Dia.: 8"
Casing: Dia.: 2" Length: 4.5 ft. blank Type:
Screen: Dia.: 2" Length: ~~7~~ ft. screen Slot Size:
Drilling Co.: Cascade Driller: Scott Krueger Logged by: C. Kilday
Drilling Meth.: auger Sampling Meth. 1.5 ft. sampler w/ 1 ft. sample
Notes:

Key: Concrete, Bentonite, Native Backfill, Sand/Gravel Pack, Well Screen

Depth (feet)	Well Construction	Sample No.	% Rec.	Blows/ Density	PID Rdg. (ppm)	Depth (feet)	Soils/Lithology
0	well box						
1							
2							
3	Bent.						
4							
5	sand	MW-12 ~~6~~ 5.5-6.5	100	35 50/6"		SP	gray/black m-c SAND, trace silt (damp, dense, no odor)
6							
7							
8							
9							
10		MW-12 11-11.5	100	13 13 15			10-11 ft. gray/black m-c SAND, trace silt
11						CL	11-11.5 ft. brown SILTY ~~SAND~~ CLAY, trace v.f. sand (damp, ~~stiff~~, no odor)
12	BOW						set well bottom at 11.5 ft. 6" into clay

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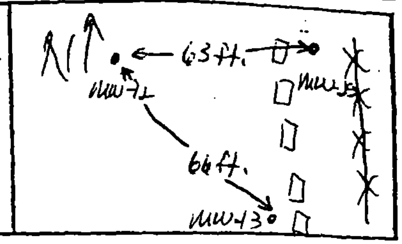
FLUOR DANIEL GTI

Well No.: MW-13

Page 1 of 1

Sketch Map



Project: Reichhold
Location: 5900 W. Marginal Way S., Seattle
Project No.: 0206000335
Date: 10/13/98
Elevation:
Well Depth: 11.5 ft.
Expl. Depth: 11.5
Hole Dia.: 8"
Casing: Dia.: 2"
Length: 4.5 ft.
Type:
Screen: Dia.: 2"
Length: 7 ft.
Slot Size:
Drilling Co.: Cascade
Driller: Scott Krueger
Logged by: C. Kilday
Drilling Meth.: Auger
Sampling Meth. 1.5 ft. sampler w/ 1 ft. sample
Notes:

Key: Concrete, Bentonite, Native Backfill, Sand/Gravel Pack, Well Screen

Depth (feet)	Well Construction	Sample No.	% Rec.	Blows/ Density	PID Rdg. (ppm)	Depth (feet)	Soils/Lithology
0	well box						
1							
2							
3							
4							
5				8		SM	black f-m SAND, some silt
6		MW-13 -5.5-6.5	100	9 9			(damp, dense, no odor)
7							
8							
9							
10				13		SP	10-11 ft. gray/black m-c SAND, trace silt
11		MW-13 -11-11.5	100	8 8		CL	11-11.5 ft. brown SILTY CLAY, trace v.f. sand (damp, stiff, no odor)
12							set well bottom at 11.5 ft.

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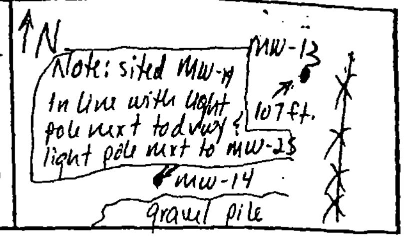
FLUOR DANIEL GTI

Well No.: MW-14

Page 1 of 1

Sketch Map



Project: Reichhold
Location: 5900 W. Marginal Way S., Seattle
Project No.: 020600335 Date: 10/13/98
Elevation: Well Depth: 11.0 ft.
Expl. Depth: 11.5 Hole Dia.: 8"
Casing: Dia.: 2" Length: 4 ft. Type:
Screen: Dia.: 2" Length: 7 ft. Slot Size:
Drilling Co.: Cascade Driller: Scott Kruger Logged by: C. Kilday
Drilling Meth.: auger Sampling Meth. 1.5 ft. sampler w/ 1 ft. sample
Notes:

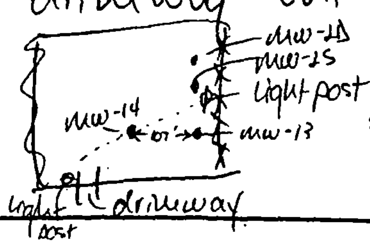
Key: Concrete, Bentonite, Native Backfill, Sand/Gravel Pack, Well Screen

Depth (feet)	Well Construction	Sample No.	% Rec.	Blows/ Density	PID Rdg. (ppm)	Depth (feet)	Soils/Lithology
0							
1	well box; concrete						
2	blank PVC						
3	Bent.						
4	sand						
5		MW-14 -5.5-6.5	100	18 33 35		SP	gray/black M-C SAND, trace silt (damp, dense, no odor) 1" layer of brown SILTY CLAY @ 6 ft. bg
6							
7							
8							
9							
10		MW-14 -10.5-11.5	100	8 8 8		SP	10.5-11 same gray/black SAND, trace silt (wet, loose, no odor)
11						CL	11-11.5 brown SILTY CLAY, trace v.f. sand (wet, med. stiff, no odor) (roots)
12							

set bottom of well @ 11.0 feet

Note: location of MW-14

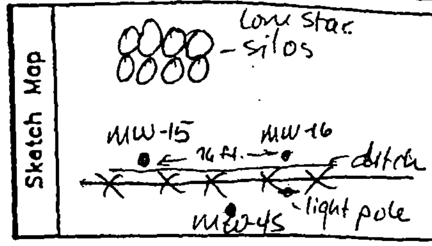
located 107 ft. SW of MW-13 in line of sight between light post next to MW-2S and light post next to driveway entrance



FLUOR DANIEL GTI

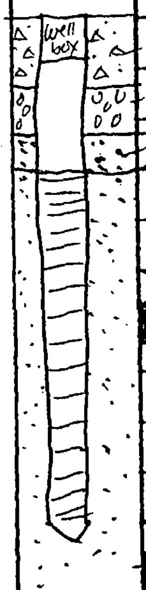
Well No.: MW-15

Page 1 of 1



Project: Reichhold
Location: 5900 W. Marginal Way S., Seattle
Project No.: 020600335
Date: 10/13/98
Elevation:
Well Depth: 10 ft.
Expl. Depth: 11.5 ft.
Hole Dia.: 8"
Casing: Dia.: 2"
Length: 3 ft.
Type:
Screen: Dia.: 2"
Length: 7 ft.
Slot Size:
Drilling Co.: Cascade
Driller: Scott Kruger
Logged by: C. Kilday
Drilling Meth.: auger
Sampling Meth. 1.5 ft. sampler w/ 1 ft. sample
Notes:

Key: Concrete, Bentonite, Native Backfill, Sand/Gravel Pack, Well Screen



Depth (feet)	Well Construction	Sample No.	% Rec.	Blows/ Density	PID Rdg. (ppm)	Depth (feet)	Soils/Lithology
0							
1	concrete						
2	bent						
3	sand / top of screen						
4							gray/black
5				17			M-C SAND, trace silt
6		MW-15 5.5-6.5	100	23		SP	(damp, medium ~~dense~~, no odor)
7				25			
8							
9							
10				5			brown SILTY CLAY, ~~[illegible]~~
11		MW-15 10.5-11.5	100	7			(wet, medium stiff, organic odor, roots)
12				8			set well bottom at 10 ft. bg

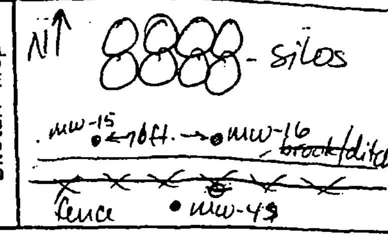
FLUOR DANIEL GTI

Well No.: MW-16

Page 1 of 1

Project: Reichhold
Location: 5900 W. Marginal Way S., Seattle
Project No.: 020600335
Date: 10/13/98
Elevation:
Well Depth: 10 ft.
Expl. Depth: 11.5 ft.
Hole Dia.: 8"
Casing: Dia.: 2"
Length: 3 ft.
Screen: Dia.: 2"
Length: 7 ft.
Drilling Co.: Cascade
Driller: Scott Kruger
Drilling Meth.: auger
Sampling Meth. 1.5 ft. sampler w/ 1 ft. sample
Notes:

Sketch Map



Type:
Slot Size:
Logged by: C. Kilday

Key: Concrete Bentonite Native Backfill Sand/Gravel Pack Well Screen

Depth (feet)	Well Construction	Sample No.	% Rec.	Blows/ Density	PID Rdg. (ppm)	Depth (feet)	Soils/Lithology
0	well box						
1	Blank PVC						
2							
3							
4							
5				11		SP	Gray/black M-C SAND, trace silt
6		MW-16 5.5-6.5	100	13			(wet, med. dense, no odor)
7				13			
8							
9							
10				4			brown SILTY CLAY, with black organic matter/roots
11		MW-16 10.5-11.5	100	5		CL	(wet, med. stiff, ~~no~~ organic odor)
12				6			
							set well bottom @ 10 ft. bg.

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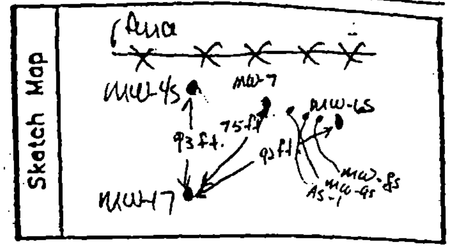
FLUOR DANIEL GTI

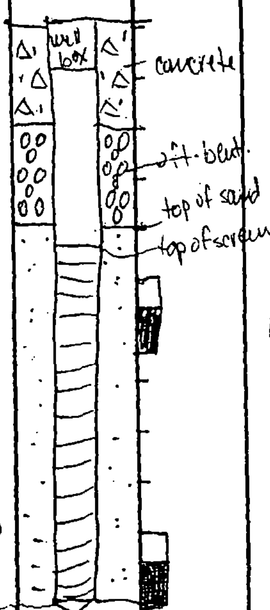
Well No.: MW-17



Page 1 of 1

Project: Reichhold
Location: 5900 W. Marginal Ways, Seattle
Project No.: 020600335
Date: 10/14/98
Elevation:
Well Depth: 11.5 ft.
Expl. Depth: 11.5 ft.
Hole Dia.: ~~8~~ 8"
Casing: Dia.: 2"
Length: 4.5 ft.
Type:
Screen: Dia.: 2"
Length: 7 ft.
Slot Size:
Drilling Co.: Cascade
Driller: Scott Krueger
Logged by: C. Kidd
Drilling Meth.: auger
Sampling Meth. 1.5 ft. sampler w/ 1 ft. sample
Notes:

Key: Concrete · Bentonite · Native Backfill · Sand/Gravel Pack · Well Screen · ☐



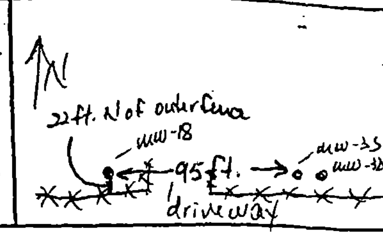
Depth (feet)	Sample No.	% Rec.	Blows/ Density	PID Rdg. (ppm)	Depth (feet)	Soils/Lithology
0						
1						
2						
3						
4						
5						4" gray/black f-m SAND and SILT (dry, ~~very stiff~~ med. dense, no odor)
6		100	33, 50/3"		SM	4" f SAND and SILT (dry, ~~very stiff~~ med. dense, no odor)
					SP	4" gray/black, m-c SAND, some silt (dry, very dense, no odor)
7						
8						
9						
10						
11		100	28 13 13		SP	same gray/black m-c SAND, trace silt (wet, med. dense, no odor)
12					CL	tip of spoon had brown SILTY CLAY, trace v.f. sand
						Bottom of well @ 11.5' bg

FLUOR DANIEL GTI

Well No.: MW-18

Page 1 of 1

Sketch Map



Project: Reichhold

Location: 5900 W. Marginal Way So., Seattle

Project No.: 020100335 Date: 10/14/98

Elevation: Well Depth: 13 ft.

Expl. Depth: 13 ft. Hole Dia.: 8"

Casing: Dia.: 2" Length: 3 ft. Type:

Screen: Dia.: 2" Length: 10 ft. Slot Size:

Drilling Co.: Cascade Driller: Scott Krueger Logged by: C. Kilday

Drilling Meth.: Auger Sampling Meth. 1.5 ft. sampler w/ 1 ft. sample

Notes:

Key: Concrete Bentonite Native Backfill Sand/Gravel Pack Well Screen

Depth (feet)	Well Construction	Sample No.	% Rec.	Blows/ Density	PID Rdg. (ppm)	Depth (feet)	Soils/Lithology
0	well box; concrete						
1	1.5 ft. bent.						
2	top of sand						
3	top of screen						
4							
5							
6		MW-18-5.5-6.5	100	21 24 29		SM	gray/black f-m SAND & SILT (dry, med. dense, no odor)
7							
8							
9							
10						SP	gray/black m-c SAND, some silt (wet, med. dense, no odor)
11		no sample	100	15 12 10			
12		MW-18-12-13	100	10,8,8		CL	brown SILTY CLAY, trace v.f. sand (wet, stiff, no odor) set well bottom @ 13 ft.
13							

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FLUOR DANIEL GTI

Well No.: MW-19

Page 1 of 1

Project: Reichhold

Location: 5900 W. Marginal Way So., Seattle

Project No.: 020600335

Date: 10/14/98

Elevation:

Well Depth: 13 ft.

Expl. Depth: 13 ft.

Hole Dia.: 8"

Casing: Dia.: 2"

Length: 3 ft.

Screen: Dia.: 2"

Length: 10 ft.

Drilling Co.: Cascade

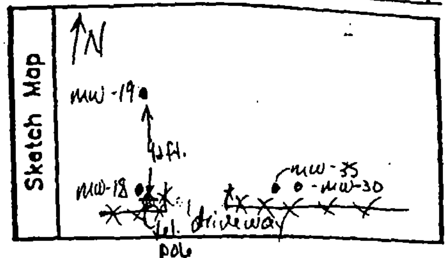
Driller: Scott Kruger

Drilling Meth.: Auger

Sampling Meth. 1.5 ft. sampler w/1 ft. sample

Notes:

Sketch Map



Type:

Slot Size:

Logged by: C. Kilday

Key: Concrete, Bentonite, Native Backfill, Sand/Gravel Pack, Well Screen

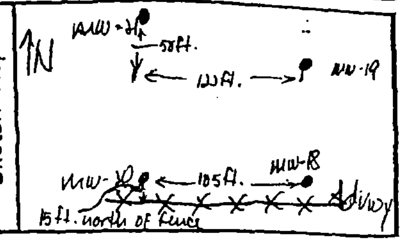
Depth (feet)	Well Construction	Sample No.	% Rec.	Blows/ Density	PID Rdg. (ppm)	Depth (feet)	Soils/Lithology
0	well box						
1							
2							
3							
4							
5							
6		MW-19 -5.5-6.5	100	7 7 8		SM	gray/black f-m SAND & SILT (dry, ~~med dense~~ loose, no odor)
7							
8							
9							
10						SP	gray/black m-c SAND, trace silt
11			100	14 16 16			(wet, med. dense, no odor)
12		MW-19 12-13	100	22 34 37		CL	brown SILTY CLAY, trace v.f. sand (wet, very stiff, no odor)
13							set well bottom @ 13 ft.

FLUOR DANIEL GTI

Well No.: MW-20

Page 1 of 1

Sketch Map



Project: Reichhold	
Location: 5900 W. Marginal Ways, Seattle	
Project No.: 020600335	Date: 10/14/98
Elevation:	Well Depth: 13 ft.
Expl. Depth: 13 ft.	Hole Dia.: 8"
Casing: Dia.: 2"	Length: 3 ft.	Type:
Screen: Dia.: 2"	Length: 10 ft.	Slot Size:
Drilling Co.: Cascade	Driller: Scott Krueger	Logged by: C. Kilday
Drilling Meth.: Auger	Sampling Meth. 1.5 ft. sampler w/ 1 ft. sample	
Notes:		

Key: Concrete, Bentonite, Native Backfill, Sand/Gravel Pack, Well Screen, ☐ ______

Depth (feet)	Well Construction	Sample No.	% Rec.	Blows/Density	PID Rdg. (ppm)	Depth (feet)	Soils/Lithology
0	well box						
1							
2							
3							
4							
5				32		SM	gray/black f-m SAND & SILT
6		MW-20 5.5-6.5		50/6"			(dry, dense, no odor)
7							
8							
9						SP	
10				16			gray/black m-c SAND, some silt
11				16 15			(wet, med. dense, no odor)
12		MW-20 12-13		11 10			same as above
13				7		CL	brown SILTY CLAY, trace v.f. sand at tip of spoon

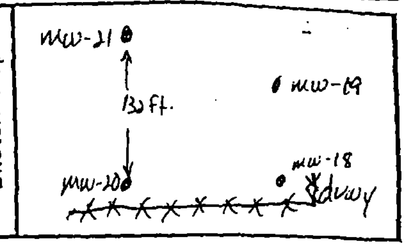
set well bottom at 13 feet bg

FLUOR DANIEL GTI

Well No.: MW-21

Page 1 of 1

Sketch Map



Project: Reichhold

Location: 5900 W. Marginal Way S., Seattle

Project No.: 0206003335 Date: 10/14/98

Elevation: Well Depth: 13 ft.

Expl. Depth: 13 feet Hole Dia.: 8"

Casing: Dia.: 2" Length: 3 ft. Type:

Screen: Dia.: 2" Length: 10 ft. Slot Size:

Drilling Co.: Cascade Driller: Scott Kruger Logged by: C. Kilday

Drilling Meth.: Auger Sampling Meth. 1.5 ft. sampler w/1 ft. sample

Notes:

Key: Concrete Bentonite Native Backfill Sand/Gravel Pack Well Screen

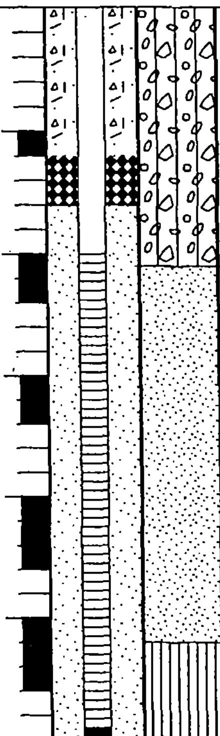
Depth (feet)	Well Construction	Sample No.	% Rec.	Blows/ Density	PID Rdg. (ppm)	Depth (feet)	Soils/Lithology
0	well box						
1							
2							
3							
4							
5							gray/black f SAND & SILT, some coarse gravel, brick fragments observed (Fill) (dry, very dense, no odor)
6		MW-21 -5.5-6.5	~~100~~ 40	70/6"			
7							
8							
9							
10							gray/black m-c SAND, some silt (wet, med. dense, no odor)
11			100	17 15 15		SP	
12							
13		MW-21 -12-13	100	7 7 6		CL	brown SILTY CLAY, trace fine sand set well bottom @ 13 feet bg.

LOG OF EXPLORATORY BORING

PROJECT NAME	**Reichhold/Lonestar Site**	BORING NO.	**MW-22**
LOCATION	**5900 West Marginal Way, Seattle, Washington**	PAGE	**1 of 1**
DRILLED BY	**Cascade Drilling, Inc.**	TOC ELEVATION	**16.73**
DRILL METHOD	**Hollow-stem Auger**	TOTAL DEPTH	**15.0'**
LOGGED BY	**Jeff Newschwander/Katlin Hanson**	DATE COMPLETED	**7/22/03**

SAMPLE NUMBER	PID (in ppm)	BLOWS PER 6 INCHES	GROUND WATER LEVEL	DEPTH IN FEET
	0	70		
1	0	27 50		5
2	0		∇	
	0	16 17 21		10
3	0	2 2 3		
				15
				20
				25

SAMPLES / WELL DETAILS / LITHOLOGIC COLUMN



LITHOLOGIC DESCRIPTION

0 to 5.25 feet: SILTY GRAVEL (GM), grayish brown (10YR 5/2), fine (20%), medium (60%), coarse (20%), dry, dense, no odor.

5.25 to 10.0 feet: POORLY GRADED SAND (SP), very dark gray (10YR 3/1), fine (5%), medium (85%), coarse (10%), damp, medium dense, no odor.

@ approximately 7.75 feet bgs: saturated.

10.0 to 13.0 feet: POORLY GRADED SAND (SP), black (10YR 2/1), fine (5%), medium (85%), coarse (10%), damp, medium dense, no odor.

13.0 to 15.0 feet: SILT (ML), dark grayish brown (10YR 4/2), damp, soft, medium plasticity, no odor.

Total depth = 15.0 feet.

WELL COMPLETION DETAILS

0 to 5.0 feet: 2-inch-diameter, flush-threaded, Schedule 40 PVC casing.

5.0 to 15.0 feet: 2-inch-diameter, flush-threaded, Schedule 40 PVC well screen with 0.020-inch machined slots and 2-inch-diameter threaded end cap.

0 to 3.0 feet: Concrete.

3.0 to 4.0 feet: Bentonite chips hydrated with potable water.

4.0 to 15.0 feet: #2/12 Monterey sand.

REMARKS

Samples submitted to laboratory for analysis: 1. MW-22-5-5.5', 2. MW-22-8-8.5', 3. MW-22-13-13.5'.

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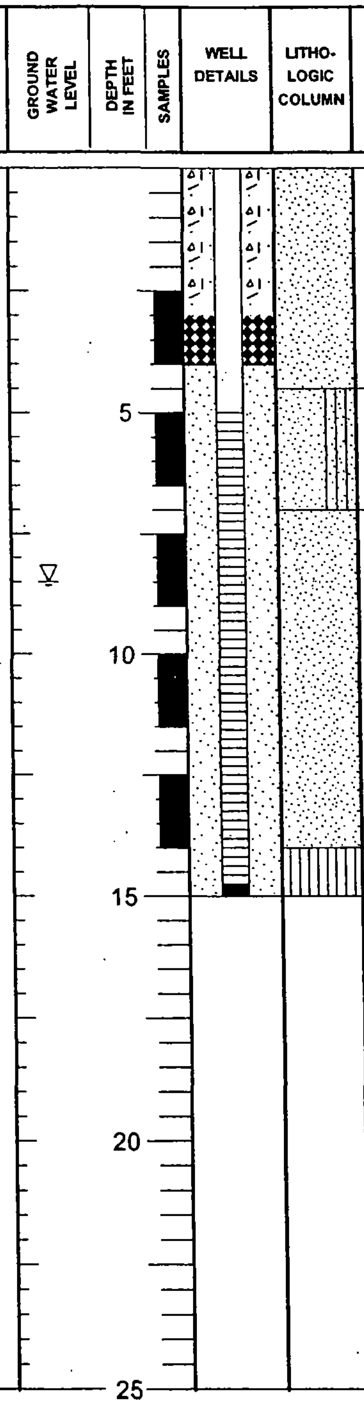
LOG OF EXPLORATORY BORING

PROJECT NAME	**Reichhold/Lonestar Site**	BORING NO.	**MW-23**
LOCATION	**5900 West Marginal Way, Seattle, Washington**	PAGE	**1 of 1**
DRILLED BY	**Cascade Drilling, Inc.**	TOC ELEVATION	**16.30**
DRILL METHOD	**Hollow-stem Auger**	TOTAL DEPTH	**15.0'**
LOGGED BY	**Jeff Newschwander/Katlin Hanson**	DATE COMPLETED	**7/22/03**

SAMPLE NUMBER	PID (in ppm)	BLOWS PER 6 INCHES
	0	10 8 6
1	0	4 3 11
2	0	6 9 12
	0	6 7 8
3	0	2 3 4



LITHOLOGIC DESCRIPTION

0 to 4.5 feet: POORLY GRADED SAND (SP), very dark gray (10YR 3/1), fine (10%), medium (85%), coarse (5%), dry, loose, no odor.

@ 3.0 feet bgs: 2-inch lens of SANDY SILT (ML).

4.5 to 7.0 feet: POORLY GRADED SAND/SILTY SAND (SP/SM), very dark grayish brown (10YR 3/2), fine (25%), medium (75%), damp, medium dense, no odor.
@ 6.0 feet bgs: 2-inch lens of SANDY SILT (ML).

7.0 to 14.0 feet: POORLY GRADED SAND (SP), very dark gray (10YR 3/1), fine (10%), medium (85%), coarse (5%), dry, medium dense, no odor.
@ 8.5 feet bgs: saturated.

@ 11.5 feet: 1-inch lens of SANDY SILT (ML).

14.0 to 15.0 feet: SILT (ML), very dark gray (10YR 3/1), damp, soft, medium plasticity, some organic material, no odor.*

Total depth = 15.0 feet.

WELL COMPLETION DETAILS

0 to 5.0 feet: 2-inch-diameter, flush-threaded, Schedule 40 PVC casing.
5.0 to 15.0 feet: 2-inch-diameter, flush-threaded, Schedule 40 PVC well screen with 0.020-inch machined slots and 2-inch-diameter threaded end cap.

0 to 3.0 feet: Concrete.
3.0 to 4.0 feet: Bentonite chips hydrated with potable water.
4.0 to 15.0 feet: #2/12 Monterey sand.

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REMARKS

Samples submitted to laboratory for analysis: 1. MW-23-5-5.5', 2. MW-23-8-8.5', 3. MW-23-13-13.5'.
* = strong methane-like odor from well; dissipated quickly.

LOG OF EXPLORATORY BORING

PROJECT NAME	**Reichhold/Lonestar Site**	BORING NO.	**MW-24**
LOCATION	**5900 West Marginal Way, Seattle, Washington**	PAGE	**1 of 1**
DRILLED BY	**Cascade Drilling, Inc.**	TOC ELEVATION	**16.28**
DRILL METHOD	**Hollow-stem Auger**	TOTAL DEPTH	**15.0'**
LOGGED BY	**Jeff Newschwander/Katlin Hanson**	DATE COMPLETED	**7/22/03**

SAMPLE NUMBER	PID (in ppm)	BLOWS PER 6 INCHES	GROUND WATER LEVEL	DEPTH IN FEET	SAMPLES	WELL DETAILS	LITHO-LOGIC COLUMN	LITHOLOGIC DESCRIPTION
1	0	6 11 16						**0 to 3.0 feet: POORLY GRADED SAND (SP),** very dark grayish brown (10YR 3/2), fine (5%), medium (80%), coarse (15%), dry, loose, no odor. **3.0 to 3.5 feet: 6-inch lens of SANDY SILT (ML),** very dark gray (10YR 3/1), no odor.
	0	11 11 11		5				**3.5 to 6.0 feet: POORLY GRADED SAND (SP),** very dark grayish brown (10YR 3/2), fine (5%), medium (95%), dry, medium dense, no odor. **6.0 to 7.5 feet: SILTY SAND (SM),** very dark grayish brown (10YR 3/2), silt (20%), fine (30%), medium (50%), damp, loose, no odor.
2	0	7 8 8	▽					**7.5 to 10.0 feet: POORLY GRADED SAND (SP),** very dark gray (10YR 3/1), fine (5%), medium (95%), dry, loose, no odor. @ 8.0 feet bgs: 2-inch lens of SANDY SILT (ML). @ 9.5 feet bgs: saturated.
	0	11 8 10		10				**10.0 to 12.0 feet: POORLY GRADED SAND (SP),** very dark gray (10YR 3/1), fine (5%), medium (95%), damp, loose, no odor.
3	0	3 3 3						**12.0 to 15.0 feet: ORGANIC SILT (OL),** very dark gray (10YR 3/1), damp, soft, medium plasticity, some organic material, no odor.
				15				Total depth = 15.0 feet.
				20				
				25				

WELL COMPLETION DETAILS

0 to 5.0 feet: 2-inch-diameter, flush-threaded, Schedule 40 PVC casing.

5.0 to 15.0 feet: 2-inch-diameter, flush-threaded, Schedule 40 PVC well screen with 0.020-inch machined slots and 2-inch-diameter threaded end cap.

0 to 3.0 feet: Concrete.

3.0 to 4.0 feet: Bentonite chips hydrated with potable water.

4.0 to 15.0 feet: #2/12 Monterey sand.

REMARKS

Samples submitted to laboratory for analysis: 1. MW-24-3.5-4', 2. MW-24-8.5-9', 3. MW-24-13-13.5'.

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REICH.gds:2.10/10/03.REICH...20600335

LOG OF EXPLORATORY BORING

PROJECT NAME	Reichhold/Lonestar Site	BORING NO.	MW-25
LOCATION	5900 West Marginal Way, Seattle, Washington	PAGE	1 of 1
DRILLED BY	Cascade Drilling, Inc.	TOC ELEVATION	17.21
DRILL METHOD	Hollow-stem Auger	TOTAL DEPTH	15.0'
LOGGED BY	Jeff Newschwander/Katlin Hanson	DATE COMPLETED	7/22/03

SAMPLE NUMBER	PID (in ppm)	BLOWS PER 6 INCHES	GROUND WATER LEVEL	DEPTH IN FEET	SAMPLES	WELL DETAILS	LITHO-LOGIC COLUMN	LITHOLOGIC DESCRIPTION
								0 to 0.25 foot: ASPHALT
								0.25 to 3.0 feet: SANDY SILT (ML), brown (10YR 4/3), dry, stiff, low plasticity, no odor.
1	0	11 11 10						**3.0 to 5.0 feet: POORLY GRADED SAND (SP)**, grayish brown (10YR 3/2), fine (5%), medium (90%), coarse (5%), damp, medium dense, no odor.
	0	6 6 7		5				**5.0 to 8.5 feet: POORLY GRADED SAND (SP)**, very dark gray (10YR 3/1), fine (5%), medium (90%), coarse (5%), damp, loose, no odor.
2	0	7 8 9						@ 8.0 feet bgs: saturated.
								8.5 to 10.5 feet: POORLY GRADED SAND (SP), very dark gray (10YR 3/1), fine (5%), medium (90%), coarse (5%), damp to wet, loose, no odor.
	0	6 9 6		10				**10.5 to 13.0 feet: POORLY GRADED SAND (SP)**, very dark gray (10YR 3/1), fine (5%), medium (90%), coarse (5%), damp, loose, no odor.
3	0	3 3 2						**13.0 to 15.0 feet: ORGANIC SILT (OL)**, very dark brown (10YR 2/2), damp, soft, low plasticity, some wood debris and peat-like organic material, no odor.
				15				Total depth = 15.0 feet.
				20				
				25				

WELL COMPLETION DETAILS

0 to 5.0 feet: 2-inch-diameter, flush-threaded, Schedule 40 PVC casing.
5.0 to 15.0 feet: 2-inch-diameter, flush-threaded, Schedule 40 PVC well screen with 0.020-inch machined slots and 2-inch-diameter threaded end cap.

0 to 3.0 feet: Concrete.
3.0 to 4.0 feet: Bentonite chips hydrated with potable water.
4.0 to 15.0 feet: #2/12 Monterey sand.

REMARKS

Samples submitted to laboratory for analysis: 1. MW-25-3.5-4', 2. MW-25-8-8.5', 3. MW-25-13-13.5'.

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LOG OF EXPLORATORY BORING

PROJECT NAME	**Reichhold/Lonestar Site**	BORING NO.	**MW-26**
LOCATION	**5900 West Marginal Way, Seattle, Washington**	PAGE	**1 of 1**
DRILLED BY	**Cascade Drilling, Inc.**	TOC ELEVATION	**16.60**
DRILL METHOD	**Hollow-stem Auger**	TOTAL DEPTH	**15.0'**
LOGGED BY	**Jeff Newschwander/Katlin Hanson**	DATE COMPLETED	**7/22/03**

SAMPLE NUMBER	PID (in ppm)	BLOWS PER 6 INCHES	GROUND WATER LEVEL	DEPTH IN FEET
	0	11 9 8		
1	0	3 4 5		5
2	0	3 4 5	∇	
3	0	3 3 4		10
4	0	3 3 3		
				15
				20
				25

LITHOLOGIC DESCRIPTION

0 to 0.25 foot: ASPHALT

0.25 to 3.5 feet: SANDY SILT (ML), brown (10YR 4/3), silts (70%), fine (20%), coarse (10%), dry, firm, little organic material, no odor.

3.5 to 5.5 feet: SILT (ML), black (Gley 2.5N), silt (60%), fine sand (20%), organic material (20%), dry, firm, no odor.

5.5 to 7.0 feet: SILT (ML), black (Gley 2.5N), silt (60%), fine sand (20%), organic material (20%), dry, firm, no odor.

7.0 to 10.0 feet: SILTY SAND (SM), very dark gray (Gley 3/N), silt (30%), fine (60%), coarse (10%), damp, very loose, no odor.
@ 8.0 feet bgs: saturated.

10.0 to 13.0 feet: SILTY SAND (SM), very dark gray (10YR 3/1), silt (45%), fine (50%), coarse (5%), damp, very loose, no odor.

13.0 to 15.0 feet: SILT WITH ORGANIC SOIL (ML/OL), very dark gray (10YR 3/1), clay (5%), silt (70%), organic material (25%), soft, damp, no odor.

Total depth = 15.0 feet.

WELL COMPLETION DETAILS

0 to 5.0 feet: 2-inch-diameter, flush-threaded, Schedule 40 PVC casing.
5.0 to 15.0 feet: 2-inch-diameter, flush-threaded, Schedule 40 PVC well screen with 0.020-inch machined slots and 2-inch-diameter threaded end cap.

0 to 3.0 feet: Concrete.
3.0 to 4.0 feet: Bentonite chips hydrated with potable water.
4.0 to 15.0 feet: #2/12 Monterey sand.

REMARKS

Samples submitted to laboratory for analysis: 1. MW-26-5.5-6', 2. MW-26-8-8.5', 3. MW-26-10.5-11', 4. MW-26-13-13.5'.

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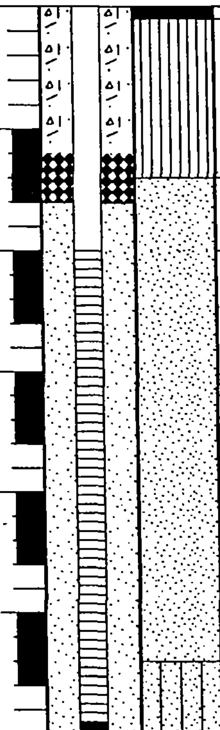
REICH.gds:4.10/13/03.REICH...20600335

LOG OF EXPLORATORY BORING

PROJECT NAME	**Reichhold/Lonestar Site**	BORING NO.	**MW-27**
LOCATION	**5900 West Marginal Way, Seattle, Washington**	PAGE	**1 of 1**
DRILLED BY	**Cascade Drilling, Inc.**	TOC ELEVATION	**16.66**
DRILL METHOD	**Hollow-stem Auger**	TOTAL DEPTH	**15.0'**
LOGGED BY	**Jeff Newschwander/Katlin Hanson**	DATE COMPLETED	**7/22/03**

SAMPLE NUMBER	PID (in ppm)	BLOWS PER 6 INCHES	GROUND WATER LEVEL	DEPTH IN FEET
	0	7 8 9		
1	0	10 14 20		5
2	0	6 18 20		
3	0	12 12 12		10
4	0	3 3 4	∇	
				15
				20
				25

SAMPLES / WELL DETAILS / LITHOLOGIC COLUMN



LITHOLOGIC DESCRIPTION

0 to 0.25 foot: ASPHALT

0.25 to 3.5 feet: SANDY SILT (ML), very dark brown (10YR 2/2), silts (75%), fine (20%), coarse (5%), dry, loose, no odor.

3.5 to 5.0 feet: POORLY GRADED SAND (SP), very dark grayish brown (10YR 3/2), fine (5%), medium (95%), dry, loose, no odor.

5.0 to 8.0 feet: POORLY GRADED SAND (SP), very dark grayish brown (10YR 3/2), fine (5%), medium (90%), coarse (5%), dry, medium dense, no odor.

8.0 to 10.0 feet: POORLY GRADED SAND (SP), brown (10YR 4/3), fine (5%), medium (90%), coarse (5%), damp, medium dense, no odor.

10.0 to 13.5 feet: POORLY GRADED SAND (SP), brown (10YR 4/3), fine (5%), medium (90%), coarse (5%), damp, medium dense, no odor.

@ 12.5 feet bgs: saturated.

13.5 to 15.0 feet: SILTY SAND (SM), very dark brown (10YR 2/2), fine (30%), medium (70%), damp, loose, no odor.

Total depth = 15.0 feet.

WELL COMPLETION DETAILS

0 to 5.0 feet: 2-inch-diameter, flush-threaded, Schedule 40 PVC casing.

5.0 to 15.0 feet: 2-inch-diameter, flush-threaded, Schedule 40 PVC well screen with 0.020-inch machined slots and 2-inch-diameter threaded end cap.

0 to 3.0 feet: Concrete.

3.0 to 4.0 feet: Bentonite chips hydrated with potable water.

4.0 to 15.0 feet: #2/12 Monterey sand.

REMARKS

Samples submitted to laboratory for analysis: 1. MW-27-5.5-6', 2. MW-27-8-8.5', 3. MW-27-10.5-11', 4. MW-27-13-13.5'.

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APPENDIX C

Soil Laboratory Reports

(provided on CD)

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APPENDIX D

Groundwater Data Laboratory Reports

(provided on CD)

APPENDIX E

Boring/Well Logs and Reports for Remediation Systems Installation

(provided on CD)